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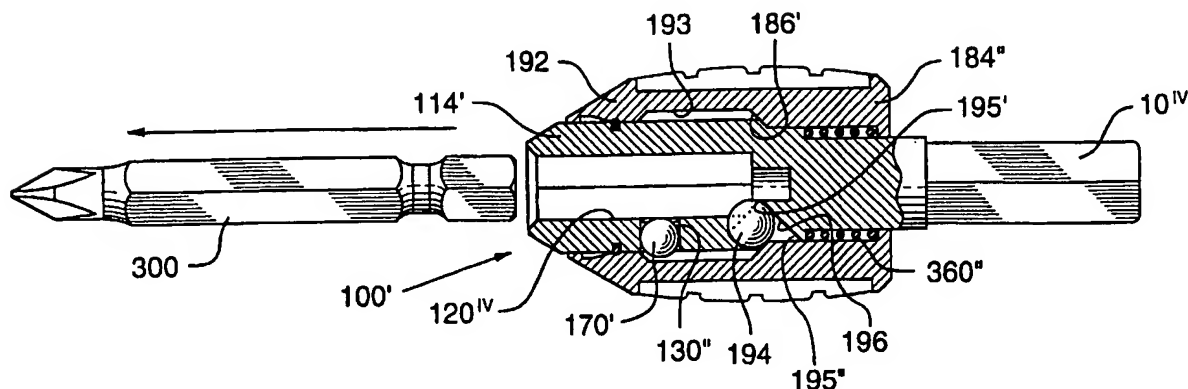
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(54) Title: QUICK-CONNECT MECHANISM



(57) Abrégé/Abstract:

A holder (100', 100'', 100''', 100'IV) having a quick-connect mechanism actuated by inserting a single- or double-ended tool bit (300, 300', 300'', 300''', 300'IV, 300'V), the tool bit engaging means to force deflection of retaining means (170', 170'', 176, 700, 700', 800), where the retaining means actuate means for engaging the tool bit, and released by manual operation of the retaining means, whereby the tool bit is pushed out from the holder so that the user can operate the tool bit holder using one hand only.

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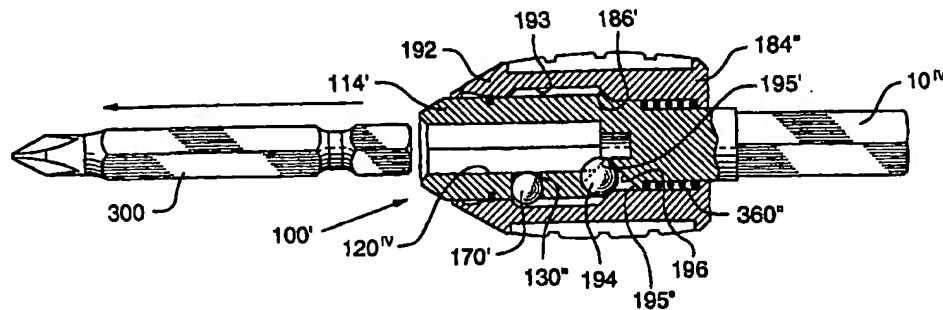


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<b>(21) International Application Number:</b> PCT/CA00/00521 <b>(22) International Filing Date:</b> 3 May 2000 (03.05.00) <b>(30) Priority Data:</b> 60/132,226 3 May 1999 (03.05.99) US <b>(71) Applicant (for all designated States except US):</b> MAXTECH MANUFACTURING INC. [CA/CA]; 620 McMurray Road, Waterloo, Ontario N2V 2E7 (CA). <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only):</b> VASUDEVA, Kailash, C. [CA/CA]; 10 Grand River Drive, Waterloo, Ontario N2J 4G8 (CA). BEDI, Sanjeev [CA/CA]; 319 Calvington Place, Waterloo, Ontario N2T 1P9 (CA). <b>(74) Agent:</b> ARMSTRONG, R., Craig; Armstrong & Associates, 285 Fountain Street South, Cambridge, Ontario N3H 1J2 (CA).		<b>(81) Designated States:</b> AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). <b>Published</b> <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>

**(54) Title:** QUICK-CONNECT MECHANISM**(57) Abstract**

A holder (100', 100'', 100''', 100'V) having a quick-connect mechanism actuated by inserting a single- or double-ended tool bit (300, 300', 300'', 300''', 300'V, 300'V), the tool bit engaging means to force deflection of retaining means (170', 170'', 176, 700, 700', 800), where the retaining means actuate means for engaging the tool bit, and released by manual operation of the retaining means, whereby the tool bit is pushed out from the holder so that the user can operate the tool bit holder using one hand only.

**QUICK-CONNECT MECHANISM****TECHNICAL FIELD**

- 5 This invention relates to a quick-connect mechanism for connecting tools to a holder, especially for use in power tools and hand tools having bit holders and exchangeable bit tools.

**BACKGROUND ART**

- 10 Traditional quick-connect mechanisms for connecting tools to a holder are shown in, for example, US 5,779,404 (Jore). This mechanism has the apparent drawback of not allowing an operator to insert and release the tool using only one hand (the other hand would be used to grip the power tool or hand tool which would power the tool/holder), necessitating the sleeve to be retracted manually to release the tool from the holder.

15

**DISCLOSURE OF INVENTION**

It is an object of the invention to provide a holder for attaching a tool bit to a power tool or a hand tool, the holder being simple to produce and assemble, due to a low parts count, and yet performing the required function flawlessly.

20

A further object of the invention is to provide a holder for attaching a tool bit to a power tool or a hand tool, which has a quick-connect mechanism actuated by inserting a bit, the bit engaging means to force retraction of a collar, where the collar actuates means for engaging the bit, and released by manual retraction of the collar, whereby the tool

25 bit is pushed out from the holder so that the user can operate the tool bit holder using one hand only.

30

In the invention, a holder for holding a tool bit comprises an elongate connector means attachable to a power tool/hand tool, the connector having a longitudinal hole with a cross-section corresponding to the cross-section of a mounting portion of the tool bit. The connector means further includes a first radial hole running from an outside surface of the connector to the longitudinal hole, the first radial hole having a large diameter

bore portion at the outside surface of the connector and a small diameter bore portion at the longitudinal hole, and a substantially truncated hemispherical shape. A substantially spherical locking ball is movably arranged in the first radial hole, cooperating with the substantially truncated hemispherical shape of the first radial hole, where the locking ball cooperates with a circumferential groove in the tool bit to lock the tool bit in place when the tool bit is fully inserted into the holder. An outer sleeve is arranged to reciprocally slide over the first connector between two end positions. The outer sleeve has a first end facing the tool bit and a second end facing the tool mount. The connector means is attachable to a power tool or hand tool via a tool mount. The outer sleeve has a stepped inside diameter, having a smaller diameter part facing the power tool or hand tool, and a larger diameter part facing the tool bit. A bevelled transition is arranged between the two different diameter parts, the bevelled transition is arranged to cooperate with a transition ball. A sleeve biasing means, for example a coil spring, is arranged to bias the sleeve away from the tool mount. The transition ball is arranged in a transition hole in the connector means. The transition hole is substantially radial, and preferably, but not necessarily, angled so that the bottom of the transition hole is arranged further from the tool mount than the top of the transition hole. Alternatively, the transition hole is substantially perpendicular to the longitudinal hole. Thus, the transition ball, which has a diameter substantially corresponding to the diameter of the transition hole, is slidable between a first position at the bottom of the transition hole, to a second position protruding from the top of the transition hole. The bevelled transition is pressed against the transition ball by the sleeve biasing means.

The sleeve is held in its end positions by a mechanism comprising a locking cavity, which cooperates with a locking ring arranged in a locking ring groove arranged on the elongate connector means, to limit the stroke of the sliding movement of the sleeve along the elongate connector means in the direction towards the tool mount or handle by the locking ring blocking further movement because the locking ring contacts the edge of the locking cavity, and in the direction towards the tool bit by the bevelled transition contacting the transition ball in its position at the bottom of the transition hole, which protrudes enough to block the movement of the sleeve when the bevelled transition contacts the larger diameter portion of the elongate connector means. In the

latter position, the sleeve is prevented from sliding towards the tool mount or handle, under the biasing influence of the biasing means, by the frictional forces present between the inside of the sleeve and the locking ring.

5 When the tool bit is inserted into the longitudinal hole, the inserted end of the tool bit will push the transition ball radially outwards in the transition hole. The transition ball is pressed by the inserted end of the tool bit, from its position at the bottom of the transition hole towards the sleeve and the bevelled transition, thus pressing the sleeve towards the tool mount or handle. A locking portion of the sleeve effectively blocks the  
10 locking ball from movement in the first radial hole, locking the tool bit in the longitudinal hole.

In a further embodiment of the invention, the sleeve has a locking cavity, which cooperates with a locking ring arranged in a locking ring groove arranged on the  
15 elongate connector means to limit the stroke of the sliding movement of the sleeve along the elongate connector means, by either edge of the locking cavity contacting the sides of the locking ring to provide the blocking of the sleeve. The outer sleeve is arranged to reciprocally slide over the connector means between two end positions, and has a stepped inside diameter, having a smaller diameter part facing the tool mount and a larger diameter part facing the tool bit. A middle diameter part is arranged  
20 between the smaller and the larger diameter parts, having a diameter which is larger than the diameter of the small diameter part but smaller than the diameter of the large diameter part. The middle diameter part is arranged to house a sleeve biasing means. A bevelled transition is arranged between the large and middle diameter parts. The  
25 bevelled transition functions similarly to the bevelled transition described for the earlier embodiment, in cooperation with a transition ball.

Further features of the invention will be described or will become apparent in the course of the following detailed description.

30

**BRIEF DESCRIPTION OF DRAWINGS**

In order that the invention may be more clearly understood, the preferred embodiment thereof will now be described in detail by way of example, with reference to the accompanying drawings, in which:

5

Fig. 1 is a sectional side view of a device according to a first embodiment of the invention, showing an exchangeable bit tool in its locked position in the tool holder,

10 Fig. 2 is a frontal view of the device of Fig. 1,

Fig. 3 is a sectional side view of the device of Fig. 1, showing the device in a position without an inserted tool bit,

15 Fig. 4 is a sectional side view of the device of Fig. 1, showing the device in a position where the outer sleeve is pulled back to release an inserted tool bit from the holder,

20 Fig. 5 is a sectional side view of an outer sleeve according to the invention,

Fig. 6 is a sectional side view of a first connector according to the invention,

Fig. 7 is a side view of a first connector according to the invention, seen from the side having the second radial hole,

25

Fig. 8 is a sectional view of a locking ball depressor according to the invention,

Fig. 9a is a top view of a guiding bar according to the invention,

30 Fig. 9b is a side view of a guiding bar according to Fig. 9a,

Fig. 10 is an elevational perspective view of a device according to a second embodiment of the invention, showing the device in a position without an inserted tool bit,

5 Fig. 11A is a sectional side view of the device according to Fig. 10, showing the device in a position where a tool bit has been inserted to the first collar displacement ball,

10 Fig. 11B is a section along line 1-1 of Fig. 11A,

Fig. 12A is a sectional side view of the device according to Fig. 10, showing the device in a position where a tool bit has been inserted to the second collar displacement ball,

15 Fig. 12B is a section along line 2-2 of Fig. 12B,

Fig. 13A is a sectional side view of the device according to Fig. 10, showing the device in a position where a tool bit has been inserted to the locking ball,

20 Fig. 13B is a section along line 3-3 of Fig. 13A,

Fig. 14A is a sectional side view of the device according to Fig. 10, showing the device in a position where a tool bit has been inserted past the locking ball,

25 Fig. 14B is a section along line 4-4 of Fig. 14A,

Fig. 15A is a sectional side view of the device according to Fig. 10, showing the device in a position where a tool bit has been inserted further past the locking ball compared to Fig. 14A,

30 Fig. 15B is a section along line 5-5 of Fig. 15A,

Fig. 16A is a sectional side view of the device according to Fig. 10, showing the device in a position where a tool bit has been inserted so the locking ball engages the groove in the tool bit,

5 Fig. 16B is a section along line 6-6 of Fig. 16A,

Fig. 17A is a sectional side view of the device according to Fig. 10, showing the device in a position where the sleeve is pushed back to allow the removal of the tool bit,

10

Fig. 17B is a section along line 7-7 of Fig. 17A,

Fig. 17C is a section along line 7-7 of Fig. 17A, showing pairs of depressor displacement balls used in a preferred embodiment of the embodiment shown in Fig. 10,

15

Fig. 18 is a sectional side view of a device according to a third embodiment of the invention, showing the device in a position where a tool bit is being inserted,

20 Fig. 19 is a sectional side view of the device according to Fig. 18, showing the device in a position where a tool bit is fully inserted,

Fig. 20 is an exploded partially sectioned view of the device according to Fig. 18, showing the device in a position where a tool bit is being inserted,

25

Fig. 21 is a sectional side view of a device according to a fourth embodiment of the invention, showing the device in a position where a tool bit is being inserted,

Fig. 22 is a sectional side view of the device according to Fig. 21, showing the device in a position where a tool bit is fully inserted,

30



- Fig. 23 is a sectional side view of the device according to Fig. 21, showing the device in a position where a tool bit is being removed,
- 5 Fig. 24 is a sectional side view of a device according to a fifth embodiment of the invention, showing the device in a position where a tool bit is being inserted,
- Fig. 25 is a sectional side view of the device according to Fig. 24, showing the device in a position where a tool bit is fully inserted,
- 10 Fig. 26 is a sectional side view of the device according to Fig. 24, showing the device in a position where a tool bit is being removed,
- Fig. 27 is a sectional side view of a device according to a sixth embodiment of the invention, showing the device in a position where a tool bit is fully inserted,
- 15 Fig. 28 is a sectional side view of the device according to Fig. 27, showing the device in a position where a tool bit is being removed,
- Fig. 29 is a sectional side view of a device according to a seventh embodiment of the invention, showing the device in a position where a tool bit is being inserted,
- 20 Fig. 30 is a sectional side view of the device according to Fig. 29, showing the device in a position where a tool bit contacts the tilting washer,
- Fig. 31 is a sectional side view of the device according to Fig. 29, showing the device in a position where a tool bit is fully inserted,
- 25 Fig. 32 is a sectional side view of the device according to Fig. 29, showing the device in a position where a tool bit is being removed,
- 30 Fig. 33A shows a top view of a first embodiment of the tilting washer according to Fig. 29,

Fig. 33B shows a top view of a second embodiment of the tilting washer according to Fig. 29,

5 Fig. 34A is a perspective elevational side view of the connector means according to Fig. 29,

Fig. 34B is a side view of the connector means according to Fig. 29,

10 Fig. 35 is a sectional side view of a device according to an alternative to the seventh embodiment of the invention,

Fig. 36A is a side view of a washer hold down means according to Fig. 35,

15 Fig. 36B is another side view of a washer hold down means according to Fig. 35,

Fig. 37A is a side view of a connecting means according to Fig. 35,

Fig. 37B is another side view of a connecting means according to Fig. 35,

20 Fig. 38A is a sectional side view of an eighth embodiment of the invention, showing the device with an inserted tool bit,

25 Fig. 38B is a sectional side view of the device according to Fig. 38A, showing the device when the tool bit is released,

Fig. 39A is a sectional side view of a ninth embodiment of the invention, showing the device with an inserted tool bit,

30 Fig. 39B is a sectional side view of the device according to Fig. 39A, showing the device when the tool bit is released,

Fig. 39C is a sectional side view of a tenth embodiment of the invention, showing the device with an inserted tool bit,

5 Fig. 40A is a sectional side view of an eleventh embodiment of the invention, showing the device with an inserted tool bit,

Fig. 40B is a sectional side view of the device according to Fig. 40A, showing the device when the tool bit is released,

10 Fig. 40C is a sectional side view of the device according to Fig. 40A, showing the device when the tool bit is inserted,

15 Fig. 41A is a sectional side view of a device according to a twelfth embodiment of the invention, showing the device in a position where a tool bit is in a position to be inserted the holder,

Fig. 41B is a sectional side view of the device according to Fig. 41A, showing the device when the tool bit is in an intermediate position during insertion,

20 Fig. 41C is a sectional side view of the device according to Fig. 41A, showing the device when the tool bit makes contact with the transition ball,

25 Fig. 41D is a sectional side view of the device according to Fig. 41A, showing the device when the tool bit is fully seated in the holder,

Fig. 41E is a sectional side view of the device according to Fig. 41A, showing the device when the tool bit is beginning to be removed from the holder by releasing the locking ball when the sleeve is pressed towards the tool bit,

30 Fig. 41F is a sectional side view of the device according to Fig. 41A, showing the device when the tool bit is further removed from the holder and loses contact with the transition ball,

Fig. 41G is a sectional side view of the device according to Fig. 41A, showing the device when the tool bit is fully removed from the holder,

5 Fig. 42A is a sectional side view of a device according to a thirteenth embodiment of the invention, showing the device in a position where a tool bit is being inserted into the holder,

10 Fig. 42B is a sectional side view of the device according to Fig. 42A, showing the device when the tool bit is further pressed into the holder,

Fig. 42C is a sectional side view of the device according to Fig. 42A, showing the device when the tool bit is locked by the locking ball,

15 Fig. 42D is a sectional side view of the device according to Fig. 42A, showing the device when the sleeve is in its locking position, to block the movement of the locking ball,

Fig. 43A is a sectional side view of the main body of the device according to Fig. 42A,

20 Fig. 43B is a side view of the main body of the device according to Fig. 43A,

Fig. 43C is a front view from the tool bit insertion side of the main body of the device according to Fig. 43A,

25 Fig. 43D is a rear view from the device mounting side of the main body of the device according to Fig. 43A,

Fig. 44A is a sectional side view of the sleeve of the device according to Fig. 42A,

30 Fig. 44B is a side view of the sleeve of the device according to Fig. 44A,

Fig. 44C is a front view from the tool bit insertion side of the sleeve of the device according to Fig. 44A,

5 Fig. 45 is a partially sectioned side view of a device according to a fourteenth embodiment of the invention, showing a rocker arm type locking mechanism,

Fig. 46A is a partially sectioned side view of the device according to Fig. 45, showing the sleeve pressed towards the tool bit for release of the tool bit from the holder,

10

Fig. 46B is a partially sectioned side view of the device according to Fig. 45, showing the sleeve pressed towards the tool bit for release of the tool bit from the holder, and the tool bit being pulled out of the holder,

15 Fig. 47A is a side view of the rocking arm according to Fig. 45,

Fig. 47B is a bottom view of the rocking arm according to Fig. 45,

20 Fig. 47C is a side view of an elongate connector means according to Fig. 45,

Fig. 47D is a partially sectioned side view of an elongate connector means according to Fig. 45,

25 Fig. 47C is a bottom view of an elongate connector means according to Fig. 45,

25

Fig. 47D is a top view of an elongate connector means according to Fig. 45,

Fig. 48A is a partially sectioned side view of a device according to a fifteenth embodiment of the invention, showing a dual cylinder type locking mechanism,

30

Fig. 48B is a partially sectioned side view of the device according to Fig. 48A, showing

the sleeve pressed towards the tool bit for release of the tool bit from the holder,

5 Fig. 48C is a partially sectioned side view of the device according to Fig. 48A, showing the sleeve pressed towards the tool bit for release of the tool bit from the holder, and the tool bit being pulled out of the holder,

Fig. 49A is a side view of a transition cylinder according to Fig. 48A,

10 Fig. 49B is a bottom view of the transition cylinder according to Fig. 48A,

Fig. 50A is a side view of a locking cylinder according to Fig. 48A,

15 Fig. 50B is a bottom view of the locking cylinder according to Fig. 48A,

Fig. 51A is a side view of an elongate connector means according to Fig. 48A,

20 Fig. 51B is a partially sectioned side view of an elongate connector means according to Fig. 48A,

Fig. 51C is a bottom view of an elongate connector means according to Fig. 48A,

Fig. 51D is a top view of an elongate connector means according to Fig. 48A,

25 Fig. 52A is a side view of a first embodiment of a double-ended tool bit, having a drill at one end and a screw bit at the other end, and having an annular groove retention means,

30 Fig. 52B is a side view of a second embodiment of a double-ended tool bit, having a drill at one end and a screw bit at the other end, and having a plurality of circular detents retention means,

Fig. 52C is a side view of a third embodiment of a double-ended tool bit, having a drill at one end and a screw bit at the other end, and having a plurality of transversely running elongate recessed retention means,

5 Fig. 52D is a side view of a fourth embodiment of a double-ended tool bit, having a drill at one end and a screw bit at the other end, and having a plurality of slotted corner retention means,

10 Fig. 53A is a partially sectioned side view of a device according to a sixteenth embodiment according to the invention, showing a pin type locking mechanism, with the double-ended tool bit in a position to be inserted into the holder,

15 Fig. 53B is a partially sectioned side view of the device of Fig. 53A, showing the double-ended tool bit in a position inserted into the holder up until the collar of the tool bit contacts the locking pin,

20 Fig. 53C is a partially sectioned side view of the device of Fig. 53A, showing the double-ended tool bit in a position inserted into the holder so that the locking pin slides on top of the collar of the tool,

25 Fig. 53D is a partially sectioned side view of the device of Fig. 53A, showing the double-ended tool bit in a position inserted into the holder and the locking pin is in a position to almost slide off the outer end of the collar of the tool bit,

Fig. 53E is a partially sectioned side view of the device of Fig. 53A, showing the double-ended tool bit in a position inserted fully into the holder up until the collar of the tool bit is locked by the locking pin,

30 Fig. 54A is a partially sectioned side view of the device of Fig. 53A, showing the double-ended tool bit fully inserted into the holder,

Fig. 54B is a partially sectioned side view of the device of Fig. 53A, showing the sleeve pushed forwards to unlock the locking pin and the double-ended tool bit in a position where the locking pin can begin travelling over the collar of the tool bit,

5 Fig. 54C is a partially sectioned side view of the device of Fig. 53A, showing the locking pin sliding on top of the collar of the tool,

Fig. 54D is a partially sectioned side view of the device of Fig. 53A, showing the locking pin in a position to almost slide off the inner end of the collar of the tool bit,

10

Fig. 54E is a partially sectioned side view of the device of Fig. 53A, showing the double-ended tool bit in a position where the locking pin has fully released the tool bit and the tool bit is ready to be removed from the holder,

15 Fig. 55A is a side view of an elongate connector means according to Fig. 53A,

Fig. 55B is a partially sectioned side view of an elongate connector means according to Fig. 53A,

20 Fig. 55C is a bottom view of an elongate connector means according to Fig. 53A,

Fig. 55D is a top view of an elongate connector means according to Fig. 53A,

Fig. 56A is a side view of an outer sleeve according to Fig. 53A,

25

Fig. 56B is a partially sectioned side view of the sleeve according to Fig. 53A,

Fig. 56C is a top view of the sleeve according to Fig. 53A,

30 Fig. 57A is a side view of a locking pin according to Fig. 53A,

Fig. 57B is a top view of the locking pin according to Fig. 53A,



Fig. 58A is a top view of a locking pin spring washer according to Fig. 53A,

Fig. 58B is a side view of a locking pin spring washer according to Fig. 53A,

5      Fig. 59    is a partially sectioned side view of a device according to a variation of the seventh embodiment of the invention, showing the device in a position where a double-ended tool bit is fully inserted in the holder,

10      Fig. 60A is a partially sectioned side view of a device according to a variation of the fourteenth embodiment of the invention, showing the device in a position where a single-ended tool bit is being inserted,

15      Fig. 60B is a partially sectioned side view of the device of Fig. 60A, showing the device in a position where a single-ended tool bit is being inserted and contacts the rocker arm,

20      Fig. 60B is a partially sectioned side view of the device of Fig. 60A, showing the device in a position where a single-ended tool bit is being inserted and contacts the rocker arm,

25      Fig. 60C is a partially sectioned side view of the device of Fig. 60A, showing the device in a position where a single-ended tool bit is being inserted has pivoted the rocker arm,

30      Fig. 60D is a partially sectioned side view of the device of Fig. 60A, showing the device in a position where a single-ended tool bit is fully inserted and the rocker arm locks into the groove of the tool bit,

35      Fig. 60E is a partially sectioned side view of the device of Fig. 60A, showing the device in a position where a single-ended tool bit is fully inserted and the sleeve is moved towards the tool bit insertion end of the holder,

Fig. 61A is a partially sectioned side view of the device of Fig. 60A, showing the device in a position where a single-ended tool bit is fully inserted in the holder,

5 Fig. 61B is a partially sectioned side view of the device of Fig. 60A, showing the device in a position where a single-ended tool bit is fully inserted and the sleeve is moved towards the tool holder end of the holder, releasing the rocker arm from the tool bit groove,

10 Fig. 61C is a partially sectioned side view of the device of Fig. 60A, showing the device in a position where a single-ended tool bit is being removed and the rocker arm is sliding on the tool bit,

15 Fig. 61D is a partially sectioned side view of the device of Fig. 60A, showing the device in a position where a single-ended tool bit is fully removed from the holder,

Fig. 61E is a partially sectioned side view of the device of Fig. 60A, showing the device in a position where a single-ended tool bit is fully removed from the holder, and the sleeve is moved to its fully biased position towards the tool bit end of the holder,

20 Fig. 62A is a partially sectioned side view of a connector means of the device of Fig. 60A,

25 Fig. 62B is a side view of a rocker arm of the device of Fig. 60A, and

Fig. 62C is a sectioned side view of a sleeve of the device of Fig. 60A,

### **BEST MODE FOR CARRYING OUT THE INVENTION**

30 Referring to Figs. 1 and 2, a holder 100, for example mounted on a power tool or a hand tool for securely holding any one of a plurality of exchangeable tool bits 300, comprises an elongate connector means 110 and an outer sleeve 180. The connector means is attachable to a power tool or a hand tool via a tool mount 10.

The connector means **110** has a central longitudinal hole **120**, which has a cross-section corresponding to the cross-section of a mounting portion **310** of the tool bit. The mounting portion of the tool bit may thus be inserted into the longitudinal hole of the connector means. The tool bit further has a profiled working portion **320** opposite the mounting portion. The connector means includes a first radial hole **130** (see Fig. 6) which runs from an outside surface **140** of the connector means to the longitudinal hole. The first radial hole has a large diameter bore portion **150** at the outside surface of the connector means and a small diameter bore portion **160** at the radial hole. The first radial hole **130** further has a substantially truncated hemispherical shape, which cooperates with a substantially spherical locking ball **170** movably arranged in the first radial hole. The locking ball may, in principle, move from a position outside the longitudinal hole to a position where the locking ball protrudes a distance into the longitudinal hole **120**, but further movement is blocked because the diameter of the small diameter portion **160** of the first radial hole is smaller than the diameter of the locking ball. The locking ball **170** cooperates with a circumferential groove **330** in the tool bit **300** to lock the tool bit in place when the tool bit is fully inserted into the holder **100**.

The outer sleeve **180** is arranged to reciprocally slide over the connector means **110** between two end positions. The outer sleeve has a first end **210** facing the tool bit **300** and a second end **220** facing the power tool or hand tool tool mount **10**. A guiding bar **230** is mounted inside the outer sleeve in a radial position, i.e. transversely mounted compared to the longitudinal direction of the outer sleeve. The guiding bar is preferably mounted in a bar groove **240** (see Fig. 5) in the outer sleeve and held in place by a guiding bar retainer **250**. The connector means **110** has a transverse through slot **260** in which the guiding bar may slide. The axial width of the through slot is larger than the radial width of the through slot, and the axial width defines the stroke of the outer sleeve **180**. The guiding bar **230** may thus slide between two end positions, defined by the axial width of the through slot of the connector means.

On the inside of the first end **210** of the outer sleeve, a stepped recess **270** is arranged. The stepped recess preferably has a first large diameter part **280** (see Fig. 5) and a second smaller diameter part **290** (see Fig. 5). Both the first part **280** and the second

part **290** have diameters which are larger than the outer diameter of the connector means **110**. A locking ball depressor **190** is arranged to reciprocally slide inside the first large diameter part of the stepped recess. The depressor preferably is formed as a ring having an inner diameter which is slightly larger than the outer diameter of the connector means **110** and an outer diameter which is slightly smaller than the diameter of the first large diameter part **280** of the stepped recess **270**. A depressor biasing means **200**, for example a coil spring, is arranged to bias the depressor against the step between the first large diameter part and the second small diameter part of the stepped recess. A first end cap **340** is arranged at the first end **210** of the outer sleeve **180** to hold the depressor biasing means inside the stepped recess **270**. The first end cap is preferably ring formed, having an outer diameter which is slightly larger than the larger diameter of the stepped recess **270**, thus enabling the first end cap to be press fit into the stepped recess, and an inside diameter which is slightly larger than the outer diameter of the connector means **110**, thus enabling the connector means to protrude through the first end cap.

On the inside of the second end **220** of the outer sleeve, a second recess **350** is arranged. The second recess has a diameter which is larger than the outer diameter of the connector means **110**. A second end cap **380** is arranged at the second end of the outer sleeve **180**. The second end cap is preferably ring formed, having an outer diameter which is slightly larger than the diameter of the second recess **350**, thus enabling the second end cap to be press fit into the second recess, and an inside diameter which is slightly larger than the outer diameter of the connector means **110**, thus enabling the connector means to protrude through the second end cap. A sleeve biasing means **360** is arranged between the guiding bar retainer **250** and a sleeve retainer means **370** to bias the outer sleeve in a direction away from the tool mount **10**. The sleeve retainer means is arranged on the part of the connector means **110** which faces the tool mount and is preferably shaped as a ring which fits in a retainer groove on the connector means.

As shown in Fig. 1, the tool bit **300** is locked in the longitudinal hole **120** of the connector means **110** by the locking ball **170**. The locking ball is prevented from moving from its position, protruding into the longitudinal hole, by the locking ball depressor **190**.

5 Fig. 3 shows a device according to the invention, without an inserted tool bit. The outer sleeve **180** is pressed to its position furthest away from the tool mount **10** by the sleeve biasing means **360**. In this position, there is enough space inside the stepped recess **270**, between the locking ball and the locking ball depressor **190**, to allow the locking ball **170** to freely move inside the first radial hole **130**. Thus, a tool bit (not shown) may be  
10 inserted into the longitudinal hole **120** of the connector means **110** without encountering resistance from the locking ball. When the tool bit is inserted, the mounting portion **310** of the tool bit hits the guiding bar **230**, thus pressing the outer sleeve **180**, against the biasing force of the sleeve biasing means **360**, towards the tool mount **10**. As the outer sleeve is pressed towards the hand tool, the locking ball depressor **190** will also be  
15 pressed towards the hand tool by the depressor biasing means **200**. The locking ball depressor will thus slide over the locking ball and block the ball in its movement in the first radial hole **130**, effectively locking the tool bit in the longitudinal hole **120**.

20 To release the tool bit **300** from the longitudinal hole **120**, the outer sleeve **180** will have to be fully pressed towards the tool mount **10** against the biasing force of the sleeve biasing means **360**, as shown in Fig. 4. The locking ball depressor **190** is then forced by the depressor biasing means to slide over the locking ball **170**, thus releasing the locking ball. The tool bit may thus be removed without excessive force.

25 In Fig. 5, the outer sleeve **180** is shown alone. The first end **210** facing the tool bit **300**, the second end **220** facing the tool mount (not shown), the guiding bar groove **240** and the stepped recess **270**, arranged on the inside of the first end of the outer sleeve, with its first large diameter part **280** and second smaller diameter part **290**, are shown as previously described.

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In Figs. 6 and 7, the connector means **110** is shown. The longitudinal hole **120**, the transverse slot **260** and the first radial hole **130**, with its large diameter bore portion **150**

at the outside surface of the connector means and the small diameter bore portion **160** at the longitudinal hole, are shown as previously described. Also the sleeve retainer means **370** is shown, although this is preferably not manufactured as an integral part of the connector means **110**.

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In Fig. 8, the locking ball depressor **190** is shown. The depressor is advantageously shaped as a ring having bevelled inner edges to facilitate the depressor sliding over the locking ball (not shown).

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In Figs. 9A and 9B, the guiding bar **230** is shown. The guiding bar is advantageously substantially rectangular with rounded short edges. The thickness of the guiding bar corresponds to the width of the guiding bar groove of the outer sleeve (not shown).

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A second embodiment of the invention is shown in Figs. 10 to 17B. In this case, the holder **100** comprises an elongate connector means **110'** and an outer sleeve **180'**. The connector means is attachable to the handle (not shown) of a power tool or a hand tool via a tool mount **10**. The connector means **110'** has a longitudinal hole **120**, which has a cross-section corresponding to the cross-section of the mounting portion of the tool bit. The mounting portion of the tool bit may thus be inserted into the longitudinal hole of the connector means. The connector means includes a first radial hole **130**, which cooperates with a substantially spherical locking ball **170** movably arranged in the radial hole, as has been described in connection with the first embodiment of the invention. The locking ball **170** cooperates with a circumferential groove in the tool bit to lock the tool bit in place when the tool bit is fully inserted into the holder **100**. The outer sleeve **180'** is arranged to reciprocally slide over the connector means **110'** between two end positions. The outer sleeve has a first end **210'** facing the tool bit and a second end **220'** facing the hand tool **10**.

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The sleeve **180'** has three inside portions of different diameters, ranging from a large diameter portion **410** at the second end **210'** of the sleeve, a small diameter portion **430** at the first end **210'** of the sleeve and a medium diameter portion **420** arranged between the large diameter portion and the small diameter portion of the sleeve. A locking ball

depressor **190** is arranged to reciprocally slide inside the large diameter portion of the sleeve. The depressor preferably is formed as a ring having an inner diameter which is slightly larger than the outer diameter of the connector means **110'** and an outer diameter which is slightly smaller than the diameter of the large diameter portion **410** of the sleeve **180'**. A depressor biasing means **360'**, for example a coil spring, is arranged to bias the depressor against the step between the large diameter portion and the medium diameter portion of the sleeve.

A first depressor displacement ball **390** is arranged in a second radial hole **395**. The second radial hole has a geometry corresponding to the first radial hole **130**, restricting the movement of the first depressor displacement ball to a movement corresponding to that of the locking ball **170**. A second depressor displacement ball **400** is arranged in a third radial hole **405**. The third radial hole has a geometry corresponding to the first radial hole **130**, restricting the movement of the second depressor displacement ball to a movement corresponding to that of the locking ball **170**. The respective radii of the first, second and third radial holes are substantially the same. The second radial hole **395** is arranged at a distance, in the longitudinal direction of the elongate connector means **110'**, from the first radial hole **130** corresponding to approximately half the radius of the radial holes and the third radial hole **405** is arranged at a distance, in the longitudinal direction of the elongate connector means **110'**, from the second radial hole **395** corresponding to approximately half the radius of the radial holes. The radial holes are thus circumferentially disposed along the outside of the elongate connector means **110'** with a certain staggering corresponding to half the radius of the radial holes. Advantageously, the first and second depressor displacement balls, **390** and **400**, respectively, are arranged in diametrically opposed pairs, so that two first depressor displacement balls are used and two second depressor displacement balls are used. In this way, a smoother and more reliable movement of the depressor **190** is achieved.

Referring to Figs. 11A and 11B, when the tool bit **300** is inserted into the elongate connector means **110'**, the mounting portion **310** of the tool bit hits the first depressor displacement ball **390**, which is pressed out of the second radial hole **395**. The first

depressor displacement ball thus presses against the locking ball depressor **190**, forcing the locking ball depressor towards the tool mount **10**.

5 When the tool bit **300** is pressed down further, as shown in Figs. 12A and 12B, the mounting portion **310** of the tool bit hits the second depressor displacement ball **400**, which is pressed out of the third radial hole **405**. The second depressor displacement ball thus presses against the locking ball depressor **190**, forcing the locking ball depressor further towards the tool mount **10**.

10 The locking ball depressor **190** is now in a position over the locking ball **170**. Further movement downwards of the tool bit **300** will cause the mounting portion **310** of the tool bit to hit the locking ball, which will be pressed out of the first radial hole **130**, as shown in Figs. 13A and 13B. The locking ball **170** will thus press against the locking ball depressor **190**, forcing the locking ball depressor still further towards the tool mount **10**,  
15 to a position of the locking ball depressor which allows the locking ball to completely exit the longitudinal hole **120** as the tool bit **300** is pressed further down, as shown in Figs. 14A and 14B.

20 In Figs. 15A and 15B, the position of the device just before the locking ball **170** enters the circumferential groove **330** in the tool bit **300** is shown.

In Figs. 16A and 16B, the tool bit **300** is fully inserted and the locking ball **170** is fully seated into the circumferential groove **330** in the tool bit **300**. The locking ball depressor **190** is now in a position over the locking ball **170**, which effectively locks the locking ball  
25 in place. The tool bit is thus held in the holder.

To release the tool bit **300** from the holder **100**, the sleeve **180'** is pulled back towards the tool mount **10** to move the locking ball depressor **190** from the position over the locking ball **170**, as is shown in Figs. 17A and 17B. The locking ball is thus free to move  
30 outwards in the first radial hole **130**, and is not blocking the removal of the tool bit. The tool bit may thus be removed from the holder.



The first depressor displacement ball **390** preferably is arranged opposite a third depressor displacement ball **500** and the second depressor displacement ball **400** preferably is arranged opposite a fourth depressor displacement ball **600**, as shown in Fig. 17C. The third depressor displacement ball is arranged in a fourth radial hole (not shown). The fourth radial hole has a geometry corresponding to the first radial hole **130**, restricting the movement of the third depressor displacement ball **500** to a movement corresponding to that of the locking ball **170**. The fourth radial hole is located 180 degrees opposite the first radial hole **395** in the connecting means **110**. The fourth depressor displacement ball **600** is arranged in a fifth radial hole (not shown). The fifth radial hole has a geometry corresponding to the first radial hole **130**, restricting the movement of the fourth depressor displacement ball to a movement corresponding to that of the locking ball **170**. The fifth radial hole is located 180 degrees opposite the second radial hole **405** in the connecting means **110**. By using two opposed pairs of depressor displacement balls, a smoother movement of the depressor **190** is provided and the risk of the depressor tilting inside the sleeve **180'**, when the depressor displacement balls press the depressor towards the tool mount **10**, is minimized.

A third embodiment of the invention is shown in Figs. 18 to 20. In this case, the holder **100** comprises an elongate connector means **110"** and an outer sleeve **180"**. The connector means is attachable to a power tool or hand tool via a tool mount **10'**. The connector means **110"** has a longitudinal hole **120'**, which has a cross-section corresponding to the cross-section of the mounting portion of the tool bit. The mounting portion of the tool bit may thus be inserted into the longitudinal hole of the connector means. The connector means includes a fourth radial hole **131**, which cooperates with a locking lever **175** arranged to pivot back and forth inside the fourth radial hole. The locking lever pivots around a pivot pin (not shown), which is arranged in pivot holes **130'** in the connecting means **110"**. The locking lever **175** cooperates with the circumferential groove in the tool bit to lock the tool bit in place when the tool bit is fully inserted into the holder **100**. The outer sleeve **180"** is arranged to reciprocally slide over the connector means **110"** between two end positions.

The sleeve 180" has a first inner circumferential recess 181 and a second inner circumferential recess 182. The first circumferential recess cooperates with and manoeuvres the locking lever between two end positions inside the fourth radial hole 131, when the sleeve slides between its two end positions. The second circumferential recess 182 cooperates with a sleeve stop 185 in a way which will be described later. A sleeve biasing means 200', for example a coil spring, is arranged to bias the sleeve 180" away from the tool mount 10'.

The connector means 110" further has a circumferential slit 115 for holding the sleeve stop 185 in position. The sleeve stop is preferably a washer-shaped disc with a slit to allow it to be compressed for mounting in the second inner circumferential recess 182. The second inner circumferential recess has a length in the longitudinal direction of the sleeve 180", which defines the throw of the sliding motion of the sleeve relative the connector means. In each end position of the throw, the sleeve stop will contact the respective side surface of the second inner circumferential recess to thereby prevent further movement of the sleeve. When a tool bit 300 is inserted into the longitudinal hole 120', the locking lever 175 end which contacts the tool bit is pushed towards the sleeve 180". After the tool bit is fully seated into the longitudinal hole, the locking lever 175 end which contacts the tool bit is free to pivot into the circumferential groove 330 in the tool bit. The sleeve biasing means 200' is arranged to transmit its spring force to the sleeve via the end of the locking lever 175 which contacts the first inner circumferential recess 181, thereby further facilitating the pivoting of the lever into the circumferential groove.

To release the tool bit 300, the sleeve 180" is manually slid away from the tool mount, whereby the locking lever 175 is forced to pivot out of the circumferential groove 330. The tool bit is now free to be removed from the longitudinal hole 120'.

A fourth embodiment of the invention is shown in Figs. 21 to 23. In this case, the holder 100 comprises an elongate connector means 110"" and an outer sleeve 184. The connector means is attachable to a power tool or hand tool via a tool mount 10". The connector means 110"" has a longitudinal hole 120", which has a cross-section corresponding to the cross-section of the mounting portion of the tool bit. The connector

means includes a first radial hole 130, which cooperates with a substantially spherical locking ball 170 movably arranged in the radial hole, as has been described in connection with the first embodiment of the invention. The locking ball 170 cooperates with the circumferential groove in the tool bit to lock the tool bit in place when the tool bit is fully inserted into the holder 100. The outer sleeve 184 is arranged to reciprocally slide over the connector means 110" between two end positions, and has a uniform inner diameter, except for a depressor stop 191 arranged on the inside of the sleeve and protruding from the sleeve. A locking ball depressor 190' is arranged to reciprocally slide inside the sleeve. The depressor preferably is formed as a ring having an inner diameter which is slightly larger than the outer diameter of the connector means 110" and an outer diameter which is slightly smaller than the inner diameter of the sleeve. A depressor biasing means 200", for example a coil spring, is arranged to bias the depressor away from the handle. A third end cap 340' is arranged at the end of the outer sleeve 184 which faces the tool bit 300, to seal the inside of the sleeve during normal use. The third end cap is preferably ring formed, having an outer diameter which is substantially the same as the outer diameter of the sleeve, and an inside diameter which is slightly larger than the outer diameter of the connector means 110", thus enabling the connector means to protrude through the first end cap. The third end cap further has an annular protrusion 341, arranged on the side of the third end cap which faces the sleeve. The annular protrusion is arranged to fit inside the sleeve 184, when the sleeve is pressed against the third end cap. The depressor 190' is pressed against the locking ball depressor stop 191 by the depressor biasing means 200".

In Fig. 21, a tool bit 300 is being inserted into the longitudinal hole 120". The inserted end of the tool bit will push the locking ball 170 radially outwards from the longitudinal hole in its radial hole (as has been described in connection with Figs. 1 and 6). The locking ball will then push the depressor 190' towards the handle, because of the bevelled edge of the depressor facing the locking ball. This allows the locking ball 170 to protrude sufficiently out of the radial hole so that the tool bit 300 may be fully inserted into the longitudinal hole 120". As the tool bit is fully inserted, the locking ball is free to be seated in the circumferential groove of the tool bit by the depressor 190' and the

sleeve **184** being biased away from the handle by the sleeve biasing means **200''**. Thus, the tool bit will be securely locked in position, as shown in Fig. 22.

To release the tool bit **300**, the sleeve **184** is slid towards the tool mount (not shown), whereby the depressor **190'** is made to slide in the same direction by the locking ball depressor stop **191**. The locking ball **170** is thus free to move in the radial hole, thus freeing the tool bit which may be removed from the longitudinal hole **120''**, as shown in Fig. 23.

A fifth embodiment of the invention is shown in Figs. 24 to 26. In this case, the holder **100** comprises an elongate connector means **114** and an outer sleeve **184'**. The connector means is attachable to a power tool or hand tool (not shown) via a tool mount **10'''**. The connector means **114** has a longitudinal hole **120'''**, which has a cross-section corresponding to the cross-section of the mounting portion of the tool bit. The connector means includes a first radial hole **130**, which cooperates with a substantially spherical locking ball **170** movably arranged in the radial hole, as has been described in connection with the first embodiment of the invention. The locking ball **170** cooperates with the circumferential groove in the tool bit to lock the tool bit in place when the tool bit is fully inserted into the holder **100**. The outer sleeve **184'** is arranged to reciprocally slide over the connector means **114** between two end positions, and has a stepped inside diameter, having a smaller diameter part facing the tool mount and a larger diameter part facing the tool bit. A bevelled transition **186** is arranged between the two diameter parts. The bevelled transition functions similarly to the depressor described for earlier embodiments. A sleeve biasing means **360'**, for example a coil spring, is arranged to bias the sleeve **184'** away from the tool mount. The bevelled transition **186** is pressed against the locking ball **170** by the sleeve biasing means **360'**. The sleeve biasing means is held in place by a biasing means stop **361** fastened on the tool mount **10'''**.

In Fig. 24, a tool bit **300** is being inserted into the longitudinal hole **120'''**. The inserted end of the tool bit will push the locking ball **170** radially outwards from the longitudinal hole in its radial hole (as has been described in connection with Figs. 1 and 6). The locking ball will then push the bevelled transition **186** towards the tool mount, and thus

the whole sleeve **184'**. This allows the locking ball **170** to protrude sufficiently out of the radial hole so that the tool bit **300** may be fully inserted into the longitudinal hole **120'''**. As the tool bit is fully inserted, the locking ball is free to be seated in the circumferential groove of the tool bit by the sleeve **184'** being biased away from the handle by the sleeve biasing means **360'**. Thus, the tool bit will be securely locked in position, as shown in Fig. 25.

To release the tool bit **300**, the sleeve **184'** is slid towards the tool mount (not shown), whereby the bevelled transition **186** no longer blocks the locking ball **170** from moving in the radial hole. The tool bit may thus be removed from the longitudinal hole **120'''**, as shown in Fig. 26.

A sixth embodiment of the invention is shown in Figs. 27 and 28. In this case, the holder **100** comprises an elongate connector means **111** and an outer sleeve **187**. The connector means is attachable to a power tool or hand tool (not shown) via a tool mount **10'''**. The connector means **111** has a longitudinal hole **121**, which has a cross-section corresponding to the cross-section of the mounting portion of the tool bit. The connector means includes a first radial hole **130**, which cooperates with a substantially spherical locking ball **170** movably arranged in the radial hole, as has been described in connection with the first embodiment of the invention. The locking ball **170** cooperates with the circumferential groove in the tool bit to lock the tool bit in place when the tool bit is fully inserted into the holder **100**. The outer sleeve **187** is arranged to reciprocally slide over the connector means **111** between two end positions, and has a stepped inside diameter, having a medium diameter part **188** facing the handle and a larger diameter part **189** facing the tool bit with a smaller diameter part between them. A spherical recess **172** is arranged in the smaller diameter part, having a shape corresponding to the spherical shape of the locking ball **170**. A sleeve biasing means **200'''**, for example a coil spring, is arranged in the larger diameter part, to bias the sleeve **187** away from the tool mount and thereby to slide the spherical recess away from the locking ball. An annular biasing means stop **115'** is arranged at the end of the connecting means **111** which faces the tool bit **300**, to prevent the sleeve biasing means from falling out of the sleeve and to provide a support surface for the biasing means. An angled channel **112** is

arranged in the connecting means 111 between the radial hole 130 and the end of the connecting means which faces the handle. The angled channel and the radial hole are connected by a connecting channel 113, arranged on the side of the connecting means which faces the sleeve. An elongate rigid arm 171 is arranged in the angled channel 112 so that a rounded end 173 of the rigid arm protrudes into the connecting channel. When  
5 no tool bit is inserted into the longitudinal hole 121 and the sleeve 187 is biased to its position closest to the tool mount, the rigid arm 171 is free to move in the angled channel, but cannot move out of the angled channel because the sleeve 187 and the bottom of the longitudinal hole 121 blocks its movement. The rounded end 173 is lodged  
10 in or near the spherical recess 172, in this position of the sleeve. When a tool bit 300 is to be inserted into the holder 100, the sleeve 187 is in a position as shown in Fig. 28, with the rounded end 173 of the rigid arm 171 blocking further movement of the sleeve towards the tool mount 10". When the inserted end of the tool bit 300 contacts the rigid arm 171, the arm is tilted away from a stop ridge 183 arranged on the inside of the  
15 sleeve 187, so that the sleeve no longer is blocked in its biased movement away from the tool bit by the rigid arm locking against the stop ridge. Thus, the sleeve will slide away from the tool bit 300 and the locking ball 170 will be pressed into the circumferential groove of the tool bit and the tool bit will be securely locked in position, as shown in Fig. 28. As the tool bit is fully inserted, the locking ball is free to be seated  
20 in the circumferential groove of the tool bit by the sleeve 187 being biased away from the tool mount by the sleeve biasing means 200".

To release the tool bit 300, the sleeve 187 is slid away from the tool mount 10", whereby a smaller diameter part 198 of the sleeve 187 no longer blocks the locking ball 170 from  
25 moving in the radial hole. The rounded end 173 of the rigid arm 171 is tilted against the stop ridge 183 arranged on the inside of the sleeve 187, so that the sleeve is blocked in its biased movement away from the tool bit by the rigid arm locking against the stop ridge. The spherical recess 172 is thus located directly above the locking ball 170. The tool bit may thus be removed from the longitudinal hole 120", as shown in Fig. 28.  
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A seventh embodiment of the invention is shown in Figs. 29 to 34B. The connector means 110" comprises a longitudinal hole 122 and an opposite tool mount 10'. The

connector means further has a substantially cylindrical enlargement **123** of the longitudinal hole at the mouth of the longitudinal hole, a longitudinal slit **177** arranged along the enlargement of the longitudinal hole and a through hole **178** arranged opposite the longitudinal slit. A washer **176**, having a substantially circular circumference, a short radial protrusion **161** and a long radial protrusion **162** opposite to the first protrusion, is arranged to reciprocally slide or tilt in the enlargement **123** of the longitudinal hole **122**. The washer further has a central hole **179**, which may be hexagonal, oval or any other cross-section which corresponds to or can accommodate the cross-section of the actual tool bit **300**. The cross-section of the central hole is preferably somewhat elongate in comparison to the cross-section of the tool bit. The first protrusion is inserted into the through hole **178** and the second protrusion is inserted into the slit **177** when the device is assembled. The outer sleeve **202** is biased away from the tool mount **10'** by a sleeve biasing means **201**, which presses on the sleeve via the second protrusion **162** of the washer **176**. The outside diameter of the washer is smaller than the inside diameter of the enlargement **123** of the longitudinal hole **122**, allowing the washer to tilt inside the enlargement. The washer **176** is prevented from tilting excessively by the first protrusion **161** cooperating with the through hole **178** and the second protrusion **162** cooperating with the slit **177**. The sleeve **202** has a profiled entry hole **203** in its end which faces away from the tool mount **10'**. The entry hole aligns the inserted tool bit **300**, which has a cross-section corresponding to the cross-section of the entry hole, the longitudinal hole **122** and the central hole **179** of the washer, with the central hole of the washer and the longitudinal hole, as is shown in Fig. 29.

In Fig. 30, the tool bit **300** has contacted the washer **176**, making the washer align itself with the outside profile of the tool bit. The washer is thus forced to tilt less, to accommodate the tool bit inside the central hole **179** of the washer, during the insertion of the tool bit. The sleeve biasing means **201** is also compressed somewhat during the insertion. When the tool bit **300** is fully inserted into the longitudinal hole **122**, as is shown in Fig. 31, the sleeve biasing means will press the second protrusion **162** of the washer **176** away from the tool holder **10'**, thus making the washer tilt as much as possible around the tool bit **300**. The tool bit is, in this way, held by the inside

circumference of the central hole 179 of the washer to prevent the tool bit from being removed from the longitudinal hole 122.

5 To remove the tool bit 300, the sleeve 202 will have to be pressed towards the tool holder 10'. The second protrusion 162 of the washer 176 will then be pressed in the same direction, making the washer tilt less. The gripping of the washer on the tool bit is thus lessened, and the tool bit may be removed.

10 An variation of the seventh embodiment of the invention is shown in Fig. 59. The central washer hole, the profiled entry hole of the sleeve and the longitudinal hole of the connector means all have to be dimensioned to accommodate the larger double-ended tool bit 300<sup>V</sup>. All reference numerals are the same for Fig. 59 as for Fig. 29.

15 In Fig. 33B, the tilting washer 176 is shown having an oval central hole 179, the first protrusion 161 and the second protrusion 162. In Fig. 33A, the tilting washer 176' is shown having an elongate hexagonal central hole 179', the first protrusion 161 and the second protrusion 162. The second protrusion is preferably somewhat curved (not shown) to fit better between the sleeve biasing means 201 and the sleeve 202. By selecting an appropriate central hole shape, the washer can cooperate with basically any cross-section shape tool. Thus, one holder can accommodate and securely hold tools of different shapes, for example both hex and round cross-section tools.

20 In Figs. 35 to 37B, an alternative embodiment to the embodiment described in Figs. 29 to 34B is shown. An outer sleeve 202' is biased away from the tool holder 10' by the sleeve biasing means 201'. A washer 176, as described above, is held in place by a washer biasing means 302. The washer biasing means is preferably an end cap, having a protruding part 303, which cooperates with the washer via a slanted end surface 304. The washer biasing means 302 further has a tool bit accommodating longitudinal centre hole 301. In Figs. 36A and 36B, the washer biasing means is shown in two side views.

25 The connecting means 116 and tool holder 10' are shown in Figs 37A and 37B, also in two side views. The longitudinal hole 122 of the connecting means is shown, together with the through hole 178 and the slit 177.

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In Figs. 38A and 38B, a twelfth embodiment of the invention is shown. The tool bit 300 cooperates with a connecting means 117, which has a longitudinal hole 122 in one side. The longitudinal opening cooperates with a sleeve protrusion 129 arranged on the outer sleeve 118. The sleeve is biased towards the tool holder 10 by a sleeve biasing means 119. The longitudinal hole 122 has a slanting side wall 125 on the side of the opening which faces away from the tool holder. The slanting side wall has a step 124 arranged in it to cooperate with an oblong resilient means 127. The resilient means has a first end 128 and a second end 126, and the resilient means is tiltingly arranged adjacent the slanting side wall 125, so that the second end is movable between one position in which the second end has entered a distance into the longitudinal hole 122 and another position in which the second end is located entirely outside the longitudinal hole. The second end is preferably bent into a rounded shape, whilst the first end is sharply bent and fixedly secured in a hole (not shown) in the slanting side wall 125. The rounded second end 126 cooperates with the groove on the tool bit 300 to hold the tool bit in place when the tool bit is inserted into the longitudinal hole 122 of the connecting means 117. To release the tool bit, the sleeve 118 is pushed away from the tool holder 10, causing the protrusion 129 to press the oblong resilient means 127 away from the tool bit 300. The tool bit is thus free to be removed.

In Figs. 39A to 40C, different additional embodiments of the invention are shown, where a release pin mechanism is used to release the sleeve in order to align a recess in the sleeve with the locking ball, so that the tool bit may be removed.

A thirteenth and preferred embodiment of the invention is shown in Figs. 41A to 41G. In this case, the holder 100' comprises an elongate connector means 114' and an outer sleeve 184". The connector means is attachable to a power tool or hand tool (not shown) via a tool mount 10<sup>IV</sup>. The connector means 114' has a longitudinal hole 120<sup>IV</sup>, which has a cross-section corresponding to the cross-section of the mounting portion of the tool bit. The connector means includes a first radial hole 130", which cooperates with a substantially spherical locking ball 170' movably arranged in the radial hole, as has been described in connection with the first embodiment of the invention. The locking ball 170' cooperates with the circumferential groove in the tool bit to lock the tool bit in place when

the tool bit is fully inserted into the holder 100'. The outer sleeve 184" is arranged to reciprocally slide over the connector means 114' between two end positions, and has a stepped inside diameter, having a smaller diameter part facing the tool mount and a larger diameter part 193 facing the tool bit. A bevelled transition 186' is arranged  
5 between the two different diameter parts. The bevelled transition functions similarly to the depressor described for earlier embodiments in cooperation with a transition ball 194, which will be described in detail later. A sleeve biasing means 360", for example a coil spring, is arranged to bias the sleeve 184" away from the tool mount. The transition ball 194 is arranged in a transition hole 195 in the connector means 114'. The transition hole  
10 is substantially radial, and preferably angled so that the bottom 195' of the transition hole is arranged further from the tool mount 10<sup>IV</sup> than the top 195" of the transition hole. Alternatively, the transition hole is substantially perpendicular to the longitudinal hole 120<sup>IV</sup>. Thus, the transition ball 194, which has a diameter substantially corresponding to the diameter of the transition hole 195, is slidable between a first position at the bottom  
15 of the transition hole, to a second position protruding from the top of the transition hole. The bevelled transition 186' is pressed against the transition ball 194 by the sleeve biasing means 360".

In Fig. 41A, a tool bit 300 is held in position to be inserted into the holder 100'. The  
20 locking ball 170' is free to slide in the radial hole 130", because the larger diameter part 193 of the sleeve 184" is located adjacent the locking ball. The sleeve biasing means 360" is pressing the sleeve and the bevelled transition 186' against the transition ball 194, which is thus forced to the bottom 195' of the transition hole 195. The sleeve is held in this position by a mechanism comprising a locking cavity 364, which cooperates with  
25 a locking ring 362 arranged in a locking ring groove 363 arranged on the elongate connector means 114', to limit the stroke of the sliding movement of the sleeve along the elongate connector means 114' in the direction towards the tool mount by the locking ring 362 blocking further movement because the locking ring contacts the edge of the locking cavity 364 (as shown in Fig. 41D), and in the direction towards the tool bit by the  
30 bevelled transition 186' contacting the transition ball 194 in its position at the bottom of the transition hole, which protrudes enough to block the movement of the sleeve 184" when the bevelled transition contacts the larger diameter portion of the elongate

connector means (see Figs. 41A, 41B, 41C, 41E, 41F and 41G). In the latter position, the sleeve is prevented from sliding towards the tool mount, under the biasing influence of the biasing means **360"**, by the frictional forces present between the inside of the sleeve and the locking ring **362**.

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As is shown in Fig. 41B, the tool bit **300** is inserted into the longitudinal hole **120<sup>IV</sup>**. The inserted end of the tool bit will push the transition ball **194** radially outwards in the transition hole **195**, as shown in Fig. 41C. The transition ball **194** is pressed by the inserted end of the tool bit, from its position at the bottom of the transition hole **195** towards the sleeve and the bevelled transition **186'**, thus pressing the sleeve towards the tool mount. A locking portion **192** of the sleeve **184"** effectively blocks the locking ball **170'** from movement in the first radial hole **130"**, locking the tool bit **300** in the longitudinal hole **120<sup>IV</sup>**, see Fig. 41D.

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Fig. 41E shows the situation when the sleeve **184"** is pressed towards the tool bit **300**, starting to release the locking ball **170'** by sliding the locking portion **192** of the sleeve forwards. The bevelled transition **186'** will push the transition ball **194** towards the tool bit, to thereby start pushing the tool bit out of the longitudinal hole **120<sup>IV</sup>**. As is shown in Figs. 41E to 41G, the locking portion **192** of the sleeve has fully cleared the locking ball, allowing the locking ball to slide up in the first radial hole **130"** sufficiently to not protrude into the longitudinal hole **120<sup>IV</sup>**. This allows the tool bit **300** to be fully removed from the longitudinal hole. The transition ball **194** is seated in the first position in the transition hole **195**, blocking any further movement of the sleeve **186"** in the direction towards the tool bit insertion hole. As soon as the tool bit has left the longitudinal hole, the locking ball can enter the longitudinal hole, as described for earlier embodiments, and thus release the sleeve **186"** for sliding towards the tool mount **10<sup>IV</sup>**, but the sleeve is prevented from sliding by the frictional forces between the sleeve and the locking ring, as described above. Thus, when inserting a tool bit into the holder, these frictional forces will have to be overcome by the user pushing the tool bit into the holder with a sufficient force to release the sleeve.

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Figs. 42A to 44D show a preferred fourteenth embodiment of a tool holder 100" according to the invention. The tool holder is similar to the tool holder according to the twelfth embodiment, but incorporates an elongate connector means 114", for accommodating double ended tools, i.e. tools having working tool tips at both ends (for instance a drill in combination with a screw driver bit). The holder functions in an identical way to the holder described in conjunction with Figs. 41A to 41G, except that the sleeve 184"" has a locking cavity 364', which cooperates with a locking ring 362' arranged in a locking ring groove 363' arranged on the elongate connector means to limit the stroke of the sliding movement of the sleeve along the elongate connector means 114", by either edge of the locking cavity contacting the sides of the locking ring to provide the blocking of the sleeve. Thus, the holder 100" comprises the elongate connector means 114" and the outer sleeve 184"". The connector means is attachable to a power tool or hand tool (not shown) via a tool mount 10<sup>V</sup>. The connector means 114" has a longitudinal hole 120<sup>V</sup>, which has a cross-section corresponding to the cross-section of the mounting portion of the tool bit. The connector means includes a first radial hole 130"", which cooperates with a substantially spherical locking ball 170" movably arranged in the first radial hole, as has been described in connection with the first embodiment of the invention. The locking ball 170" cooperates with the circumferential groove 305 in the tool bit to lock the tool bit in place when the tool bit is fully inserted into the holder 100". The outer sleeve 184"" is arranged to reciprocally slide over the connector means 114" between two end positions, and has a stepped inside diameter, having a smaller diameter part 125' facing the handle and a larger diameter part 122' facing the tool bit. A middle diameter part 123' is arranged between the smaller and the larger diameter parts, having a diameter which is larger than the diameter of the small diameter part but smaller than the diameter of the large diameter part. The middle diameter part is arranged to house a sleeve biasing means 360"". A bevelled transition 186" is arranged between the large and middle diameter parts. The bevelled transition functions similarly to the depressor described for earlier embodiments in cooperation with a transition ball 194', which will be described in detail later. The sleeve 184"" has a first end 210" facing a tool bit insertion hole (longitudinal hole) 120<sup>V</sup>, and a second end 220" facing the tool mount 10<sup>V</sup>, when the sleeve is mounted on the tool holder 100". The sleeve biasing means 360"", for example a coil spring, is arranged to bias the sleeve

184''' away from the handle. The transition ball 194' is arranged in a transition hole 197 in the connector means 114'. The transition hole is substantially radial. Thus, the transition ball 194, which has a diameter substantially corresponding to the diameter of the transition hole 195, is slidable between a first position at the bottom of the transition hole, to a second position protruding from the top of the transition hole. The bevelled transition 186'' is pressed against the transition ball 194' by the sleeve biasing means 360'''. The longitudinal hole 120<sup>V</sup> has a large diameter portion 121' adjacent the tool bit insertion end.

10 In Fig. 42D, a tool bit 300' is held in the longitudinal hole 120<sup>V</sup>. The inserted end of the tool bit will push the transition ball 194' radially outwards in the transition hole 197. A locking portion 192' of the sleeve 184''' effectively blocks the locking ball 170'' from movement in the first radial hole 130''', locking the tool bit 300' in the longitudinal hole 120<sup>V</sup>.

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Fig. 42C shows the situation when the sleeve 184''' is pressed towards the tool bit 300', starting to release the locking ball 170'' by sliding the locking portion 192' of the sleeve forwards. The bevelled transition 186'' will push the transition ball 194' towards the tool bit, to thereby start pushing the tool bit out of the longitudinal hole 120<sup>V</sup>. As is shown in Figs. 42C and 42B, the locking portion 192' of the sleeve has fully cleared the locking ball, allowing the locking ball to slide up in the first radial hole 130''' sufficiently to not protrude into the longitudinal hole 120<sup>V</sup>. This allows the tool bit 300' to be fully removed from the longitudinal hole. The transition ball 194' is seated in the first position in the transition hole 195, blocking any further movement of the sleeve 186''' in the direction towards the tool bit insertion hole. As soon as the tool bit has left the longitudinal hole, the locking ball can enter the longitudinal hole, as described for earlier embodiments, and thus release the sleeve 186''' for sliding towards the tool mount 10<sup>V</sup>(not shown).

20 To insert the tool bit 300', it is inserted into the longitudinal hole 120<sup>V</sup> and pressed down until it is seated at the bottom of the longitudinal hole, simultaneously as the sleeve 184''' is pressed towards the tool bit side of the holder 100''. The bottom portion of the tool bit will then first press the locking ball 170'' up in the first radial hole 130'''. The sleeve is

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blocked from sliding towards the tool mount **10<sup>v</sup>** by the transition ball pressing against the bevelled transition **186"**. The situation is identical to what is shown in Fig. 42A, but the tool bit is inserted instead of removed. By inserting the tool bit further, the groove of the tool bit will align with the locking ball **170"**, allowing the locking ball to slide into the groove, whereby the sleeve **184""** will be slid towards the tool mount **10<sup>v</sup>** as described earlier. The locking portion **192'** of the sleeve **184""** will block the locking ball and the tool bit is ready for use in the holder **100"**.

An alternative embodiment to the fourteenth embodiment is shown in Figs. 48A to 51D. The locking ball is replaced in function with a substantially cylindrical locking bar **800**, and the transition ball is replaced in function with a substantially cylindrical transition bar **810**, having a flat side **820**. The locking bar is arranged to slide in a radial first hole **830**, in the same way as described earlier regarding the locking ball. The transition bar **810** is arranged to slide in a second hole **840**, in the same way as described earlier regarding the transition ball. Thus, the functioning of the holder according to Figs. 48A to 51D is identical to the fourteenth embodiment, described earlier. The flat side **820** of the transition bar **810** facilitates the proper orientation of the transition bar but is not essential to the functioning of the holder.

Figs. 45 to 47E show a preferred fifteenth embodiment of a tool holder **100""** according to the invention. The tool holder is similar to the tool holder according to the fourteenth embodiment described earlier. The holder functions in an identical way to the holder described in conjunction with Figs. 48A to 51D, except that a rocker arm **700**, having a substantially cylindrical locking end **710**, a substantially cylindrical transition end **720**, a connecting bar **730**, fixedly connecting the locking end and the transition end, and a pivot shaft **740** fixedly and perpendicularly arranged in the connecting bar, is pivotably arranged in a rocking arm hole **750** arranged in a connector means **114"**, pivoting on the pivot shaft, which is held by a first rocking arm hole extension **760** and a second rocking arm hole extension **761**. Thus, the holder **100"** comprises the elongate connector means **114"** and an outer sleeve **184""**. The connector means is attachable to a power tool or hand tool (not shown) via a tool mount **10<sup>v</sup>**. The connector means **114"** has a longitudinal hole **120<sup>v</sup>**, which has a cross-section corresponding to the cross-section of

the mounting portion of the tool bit. The locking end 710 cooperates with the circumferential groove 305 in the tool bit to lock the tool bit in place when the tool bit is fully inserted into the holder 100<sup>'''</sup>. The outer sleeve 184<sup>'''</sup> is arranged to reciprocally slide over the connector means 114<sup>''</sup> between two end positions, and has a stepped inside diameter, having a smaller diameter part 125' facing the handle and a larger diameter part 122' facing the tool bit (for reference numerals of the sleeve see Fig. 44A). A middle diameter part 123' is arranged between the smaller and the larger diameter parts, having a diameter which is larger than the diameter of the small diameter part but smaller than the diameter of the large diameter part. The middle diameter part is arranged to house a sleeve biasing means 360<sup>'''</sup>. A bevelled transition 186<sup>''</sup> is arranged between the large and middle diameter parts. The bevelled transition functions similarly to the depressor described for earlier embodiments in cooperation with the transition end 720, which will be described in detail later. The sleeve 184<sup>'''</sup> has a first end 210<sup>''</sup> facing the tool bit insertion hole (longitudinal hole) 120<sup>v</sup>, and a second end 220<sup>''</sup> facing the tool mount 10<sup>v</sup>, when the sleeve is mounted on the tool holder 100<sup>'''</sup>. The sleeve biasing means 360<sup>'''</sup>, for example a coil spring, is arranged to bias the sleeve 184<sup>'''</sup> away from the handle. The transition end 720 is pivotable between a first position at the bottom of the rocking arm hole 750, to a second position protruding from the top of the rocking arm hole. The bevelled transition 186<sup>''</sup> is pressed against the transition end 720 by the sleeve biasing means 360<sup>'''</sup>.

In Fig. 45, a tool bit 300' is held in the longitudinal hole 120<sup>v</sup>. The inserted end of the tool bit will push the transition end 720 radially outwards in the rocker arm hole 750. A locking portion 192' of the sleeve 184<sup>'''</sup> effectively blocks the locking end 710 from movement in the rocking arm hole 750, locking the tool bit 300' in the longitudinal hole 120<sup>v</sup>.

Fig. 46A shows the situation when the sleeve 184<sup>'''</sup> is pressed towards the tool bit 300', starting to release the locking end 710 by sliding the locking portion 192' of the sleeve forwards. The bevelled transition 186<sup>''</sup> will push the transition end 720 towards the tool bit, to thereby pivot the rocking arm simultaneously as it will start pushing the tool bit out of the longitudinal hole 120<sup>v</sup>. As is shown in Fig. 46B, the locking portion 192' of the sleeve has fully cleared the locking end, allowing the locking end to pivot up in the rocker

arm hole 750 sufficiently to not protrude into the longitudinal hole 120<sup>v</sup>. This allows the tool bit 300' to be fully removed from the longitudinal hole. The transition end 720 is seated in the first position, blocking any further movement of the sleeve 186''' in the direction towards the tool bit insertion hole. As soon as the tool bit has left the longitudinal hole, the locking end can enter the longitudinal hole, as described for earlier embodiments, and thus release the sleeve 186''' for sliding towards the tool mount 10<sup>v</sup>(not shown).

To insert the tool bit 300', it is inserted into the longitudinal hole 120<sup>v</sup> and pressed down until it is seated at the bottom of the longitudinal hole, simultaneously as the sleeve 184''' is pressed towards the tool bit side of the holder 100'''. The bottom portion of the tool bit will then first pivot the locking end 710 up in the rocker arm hole 750. The sleeve is blocked from sliding towards the tool mount 10<sup>v</sup> by the transition end pressing against the bevelled transition 186''. By inserting the tool bit further, the groove of the tool bit will align with the locking end 710, allowing the locking end to pivot into the groove, whereby the sleeve 184''' will be slid towards the tool mount 10<sup>v</sup> as described earlier. The locking portion 192' of the sleeve 184''' will block the locking end and the tool bit is ready for use in the holder 100'''.

An alternative embodiment to the device shown in Fig. 45 (the fifteenth embodiment) is shown in Figs. 60A to 62C. This embodiment is used for single-ended tool bits 300. A rocker arm 700'', having a substantially cylindrical locking end 710', a substantially cylindrical transition end 720', a connecting bar 730', fixedly connecting the locking end and the transition end, and a pivot shaft 740' fixedly and perpendicularly arranged in the connecting bar, is pivotably arranged in a rocking arm hole 750' arranged in a connector means 114<sup>vi</sup>, pivoting on the pivot shaft, which is held by a first rocking arm hole extension 760' and a second rocking arm hole extension (not shown, same as Fig. 47C). Thus, the holder 100<sup>v</sup> comprises the elongate connector means 114<sup>vi</sup> and an outer sleeve 184<sup>vii</sup>. The connector means is attachable to a power tool or hand tool (not shown) via a tool mount 10<sup>v</sup>. The connector means 114<sup>vi</sup> has a longitudinal hole 120<sup>viii</sup>, which has a cross-section corresponding to the cross-section of the mounting portion of the tool bit. The locking end 710' cooperates with the circumferential groove 330 in the



tool bit to lock the tool bit in place when the tool bit is fully inserted into the holder **100<sup>V</sup>**.  
 The outer sleeve **184<sup>VII</sup>** is arranged to reciprocally slide over the connector means **114<sup>VI</sup>**  
 between two end positions, and has a slanted inside diameter, having a first slanted part  
**122<sup>II</sup>** facing the tool mount and a second slanted part **122<sup>III</sup>** facing the tool bit. A larger  
 5 diameter part **122<sup>IV</sup>** is arranged to press a transition ridge (or cam) **721** of the rocker arm  
**700<sup>II</sup>**, when the sleeve is slid over the rocker arm. The constant pressure applied by the  
 larger diameter part against the rocker arm transition ridge eliminates any play in the  
 locking of the tool bit in the holder by the locking portion **710<sup>I</sup>** of the rocking arm **700<sup>II</sup>**.  
 Thus any unwanted tool bit movement in the holder is eliminated. The second slanted  
 10 part **122<sup>III</sup>** can alternatively be shaped as a step (not shown). A sleeve biasing means  
**360<sup>III</sup>** is housed in a further larger diameter portion of the sleeve, for pressing the sleeve  
 towards the tool bit insertion side of the holder. The transition end **720<sup>I</sup>** is pivotable  
 between a first position at the bottom of the rocking arm hole **750<sup>I</sup>**, to a second position  
 protruding from the top of the rocking arm hole. Insertion of the tool bit, (Figs. 60A to  
 15 60E) and removal of the tool bit (Figs. 61A to 61E) is performed analogous to what is  
 described above for the fifteenth embodiment.

Figs. 52A to 52G show different embodiments of double-ended tool bits, which are  
 suitable for use with a holder according to the invention. Fig. 52A shows a double-ended  
 20 tool holder **300<sup>I</sup>** as earlier described, having a first tool **306** at one end, for example a  
 screw bit, a second tool **307** at the opposite end, for example a drill, and a waist portion  
**308** with a circumferential groove **305**. The locking ball/locking end described for  
 different embodiments of the invention, advantageously cooperates with the groove **305**  
 to hold the tool bit **300<sup>I</sup>** in the holder. Alternatively, the locking ball/locking end can  
 25 cooperate with either end of the waist portion **308**, to securely hold the tool bit in place.  
 Fig. 52B shows a further embodiment of a double-ended tool holder **300<sup>II</sup>**, having a first  
 tool **306** at one end, for example a screw bit, a second tool **307** at the opposite end, for  
 example a drill, and a waist portion **308<sup>I</sup>** with a plurality of circumferentially arranged  
 circular depressions **305<sup>I</sup>**. The locking ball/locking end described for different  
 30 embodiments of the invention, advantageously cooperates with the circular depressions  
**305<sup>I</sup>** to hold the tool bit **300<sup>II</sup>** in the holder. Alternatively, the locking ball/locking end can  
 cooperate with either end of the waist portion **308<sup>I</sup>**, to securely hold the tool bit in place,

as described earlier. Fig. 53C shows a still further embodiment of a double-ended tool holder **300'''**, having a first tool **306** at one end, for example a screw bit, a second tool **307** at the opposite end, for example a drill, and a waist portion **308''** with a plurality of circumferentially arranged concave and elongate first cutouts **305''**. The locking ball/locking end described for different embodiments of the invention, advantageously cooperates with the first cutouts **305''** to hold the tool bit **300''** in the holder. Alternatively, the locking ball/locking end can cooperate with either end of the waist portion **308''**, to securely hold the tool bit in place, as described earlier. Fig. 53D, finally, shows yet a further embodiment of a double-ended tool holder **300<sup>IV</sup>**, having a first tool **306** at one end, for example a screw bit, a second tool **307** at the opposite end, for example a drill, and a waist portion **308'''** with a plurality of circumferentially arranged second cutouts **305'''**. The second cutouts are arranged at the corners of the hex cross-section waist portion. The locking ball/locking end described for different embodiments of the invention, advantageously cooperates with the second cutouts **305'''** to hold the tool bit **300'''** in the holder. Alternatively, the locking ball/locking end can cooperate with either end of the waist portion **308'''**, to securely hold the tool bit in place, as described earlier.

A sixteenth and preferred embodiment of the invention is shown in Figs. 53A to 58B. The holder functions in an identical way to the holder described in conjunction with Figs. 48A to 51D, except that a locking pin **700'**, having a first end **701** with a first slanted surface **703**, a second end **702** with a second slanted surface **705**, a protruding stop **704** arranged substantially around a middle portion of the locking pin, is slidably arranged in a first radial hole **830'** arranged in a connector means **114<sup>V</sup>**. Advantageously, the locking pin **700'** is biased away from the longitudinal hole **120<sup>VI</sup>** by a resilient spring washer (see Figs. 58A and 58B), having a central cutout **707** corresponding to the cross-section of the locking pin, and a generally curved shape. Thus, the holder **100<sup>IV</sup>** comprises the elongate connector means **114<sup>V</sup>** and an outer sleeve **184<sup>IV</sup>**. The connector means is attachable to a power tool or hand tool (not shown) via a tool mount **10<sup>VI</sup>**. The connector means **114<sup>V</sup>** has a longitudinal hole **120<sup>VI</sup>**, which has a cross-section corresponding to the cross-section of the mounting portion of the tool bit, and a larger diameter portion **120<sup>VII</sup>**, corresponding to a waist portion **308** of the tool bit (as defined earlier). The second end **702** of the locking pin **700'** cooperates with the waist portion **308** of the tool

bit to lock the tool bit in place when the tool bit is fully inserted into the holder 100<sup>IV</sup>. The outer sleeve 184<sup>IV</sup> is arranged to reciprocally slide over the connector means 114<sup>V</sup> between two end positions, and has a stepped inside diameter, having a smaller diameter part 192' facing the tool bit insertion side and a larger diameter part 193' facing the tool mount 10<sup>IV</sup>. A bevelled part 191' is arranged between the smaller and the larger diameter parts. The bevelled part is arranged to cooperate with the first end 701 of the locking pin 700' as the locking pin slides up or down. A sleeve biasing means 360<sup>IV</sup> is arranged to press the sleeve towards the tool mount 10<sup>IV</sup>. The bevelled part 191' is pressed against the locking pin 700' by the sleeve biasing means 360<sup>IV</sup>.

To insert the tool bit 300<sup>V</sup>, see Figs. 53A to 53E, the tool bit is inserted into the longitudinal hole 120<sup>VI</sup> and pressed down until it is seated at the bottom of the longitudinal hole, simultaneously as the sleeve 184<sup>IV</sup> is pressed towards the tool bit side of the holder 100<sup>IV</sup>. The second slanted surface 705 of the second end 702 of the locking pin 700' will first contact the tool bit, see Fig. 53B, whereby the locking pin 700' is pressed up in the first radial hole 830', causing the sleeve to be pressed towards the tool bit. By inserting the tool bit further, see Figs. 53C and 53D, the locking pin 700' will slide over the waist portion 308 of the tool bit. As is shown in Fig. 53E, the locking pin 700' eventually contacts one end of the waist portion 308, whereby the tool bit is securely held in the holder 100<sup>IV</sup>. The sleeve 184<sup>IV</sup> is slid towards the stop ring 365", arranged in an annular recess 363' of the connecting means 114<sup>V</sup>, because the locking pin 700' is allowed to enter the first radial hole 830' slightly and thus does not block the movement of the sleeve in its biased direction.

In Fig. 54A, the tool bit 300<sup>V</sup> is held in the longitudinal hole 120<sup>VI</sup> of the holder. If the sleeve 184<sup>IV</sup> is pressed towards the tool bit 300<sup>V</sup>, the locking pin 700' is no longer pressed towards the longitudinal hole, and is instead pressed in the opposite direction by the spring washer 706. The tool bit 300<sup>V</sup> can thus be fully removed from the longitudinal hole.

The device according to any of the described embodiments of the invention adds safety to the use of the device, because the device automatically locks the tool bit in the holder

after insertion. No action, other than the insertion itself, has to be performed by the user to insert and lock the tool bit in place. As a safeguard, the device has to be actively manipulated in order to release the tool bit from the holder again, but the tool bit will be automatically dislodged during this manipulation, so that the tool bit can be removed  
5 from the holder using only one hand.

It will be appreciated that the above description relates to the preferred embodiments by way of example only. Many variations on the invention will be obvious to those knowledgeable in the field, and such obvious variations are within the scope of the  
10 invention as described and claimed, whether or not expressly described. For example, one or more locking balls/locking bars/rocker arms may be employed to achieve the locking function of the invention.

#### **INDUSTRIAL APPLICABILITY**

15 The invention provides an improved holder for holding a tool, for use with power tools or hand tools.

**CLAIMS**

1. A holder (100') for holding a tool bit (300), the holder comprising:
  - an elongate connector (114') attachable to a power tool/hand tool via a tool mount (10<sup>IV</sup>), the connector having a longitudinal hole (120<sup>IV</sup>) with a cross-section corresponding to the cross-section of a mounting portion of the tool bit and a first radial hole (130') running from an outside surface of the connector to the longitudinal hole, the first radial hole having a large diameter bore portion at the outside surface of the connector and a small diameter bore portion at the longitudinal hole, and a substantially truncated hemispherical shape;
  - a substantially spherical locking ball (170') movably arranged in the first radial hole, cooperating with the substantially truncated hemispherical shape of the first radial hole, the locking ball cooperating with a circumferential groove (330) in the tool bit to lock the tool bit in place when the tool bit is fully inserted into the holder;
  - a sleeve (184'') arranged to reciprocally slide over the connector between two end positions, having a first end facing the tool bit and a second end facing the hand tool, a stepped inside diameter, having a smaller diameter part facing the power tool or hand tool, and a larger diameter part (193) facing the tool bit, and a bevelled transition (186') arranged between the smaller diameter part and the larger diameter part;
  - a sleeve biasing means (360'') arranged to bias the sleeve away from the tool mount;
  - a transition ball (194) arranged in a transition hole (196) in the connector, the transition hole being substantially radial, the transition ball having a diameter substantially corresponding to the diameter of the transition hole and being slidable between a first position at a bottom of the transition hole, to a second position where the transition ball protrudes from a top of the transition hole towards the sleeve, the bevelled transition being arranged to cooperate with the transition ball by pressing against the transition ball by the sleeve biasing means,
  - a mechanism for holding the sleeve between end positions, comprising a locking cavity (364), which cooperates with a locking ring (362) arranged in a locking ring groove (363) arranged on the connector, to limit the stroke of the sliding movement of the sleeve along the connector in a direction towards the tool mount by the locking ring blocking

further movement because the locking ring contacts the edge of the locking cavity, and in a direction towards the tool bit by the bevelled transition contacting the transition ball in its position at the bottom of the transition hole, the transition ball protruding enough to block the movement of the sleeve when the bevelled transition contacts the larger diameter portion of the connector, thus, preventing the sleeve from sliding towards the tool mount or handle, under the biasing influence of the biasing means, by the frictional forces present between the inside of the sleeve and the locking ring, a locking portion (192) of the sleeve effectively blocking the locking ball from movement in the first radial hole, locking the tool bit in the longitudinal hole when the sleeve is in this position.

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2. A holder according to claim 1, wherein the transition hole is angled, so that the bottom of the transition hole is arranged further from the tool mount than the top of the transition hole.

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3. A holder according to claim 1, wherein the transition hole is substantially perpendicular to the longitudinal hole.

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4. A holder according to claim 1, wherein the tool bit is a double-ended tool bit having a first tool type (306) at one end and a second tool type (307) at the opposite end.

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5. A holder (100") for holding a tool bit, the holder comprising:  
an elongate connector (114") attachable to a power tool/hand tool via a tool mount (10<sup>v</sup>), the connector having a longitudinal hole (120<sup>v</sup>) with a cross-section corresponding to the cross-section of a mounting portion of the tool bit and a first radial hole (130") running from an outside surface of the connector to the longitudinal hole, the first radial hole having a large diameter bore portion at the outside surface of the connector and a small diameter bore portion at the longitudinal hole, and a substantially truncated hemispherical shape;

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a substantially spherical locking ball (170") movably arranged in the first radial hole, cooperating with the substantially truncated hemispherical shape of the first radial

hole, the locking ball cooperating with a circumferential groove (305) in the tool bit to lock the tool bit in place when the tool bit is fully inserted into the holder;

a sleeve (184''') arranged to reciprocally slide over the connector between two end positions, having a first end facing the tool bit and a second end facing the hand tool, a stepped inside diameter, having a smaller diameter part facing the power tool or hand tool, and a larger diameter part facing the tool bit, and a bevelled transition (186'') arranged between the smaller diameter part and the larger diameter part;

a sleeve biasing means (360''') arranged to bias the sleeve towards the tool mount;

a transition ball (194') arranged in a transition hole (197) in the connector, the transition hole being substantially radial, the transition ball having a diameter substantially corresponding to the diameter of the transition hole and being slidable between a first position at a bottom of the transition hole, to a second position where the transition ball protrudes from a top of the transition hole towards the sleeve, the bevelled transition being arranged to cooperate with the transition ball by pressing against the transition ball by the sleeve biasing means,

a mechanism for holding the sleeve between end positions, comprising a locking cavity (364), which cooperates with a locking ring (362') arranged in a locking ring groove (363') arranged on the connector to limit the stroke of the sliding movement of the sleeve along the connector, by either edge of the locking cavity contacting the sides of the locking ring to provide the blocking of the sleeve, the sleeve having a stepped inside diameter, with a smaller diameter part (125') facing the handle and a larger diameter part (122') facing the tool bit, and a middle diameter part (123') arranged between the smaller and the larger diameter parts, the middle diameter part having a diameter which is larger than the diameter of the small diameter part but smaller than the diameter of the large diameter part, and being arranged to house the sleeve biasing means, the bevelled transition being arranged between the large and middle diameter parts.

6. A holder according to claim 5, wherein the transition hole is angled, so that the bottom of the transition hole is arranged further from the tool mount than the top of the transition hole.

7. A holder according to claim 5, wherein the transition hole is substantially perpendicular to the longitudinal hole.

8. A holder according to claim 5, wherein the tool bit is a double-ended tool bit having a first tool type (306) at one end and a second tool type (307) at the opposite end.

9. A holder for holding a tool bit, the holder comprising:  
 an elongate connector (110") attachable to a power tool/hand tool via a tool mount (10'), the connector having a longitudinal hole (122) with a cross-section corresponding to the cross-section of a mounting portion of the tool bit, the longitudinal hole further having a substantially cylindrical enlargement (123) at a mouth of the longitudinal hole, a longitudinal slit (177) arranged along the enlargement of the longitudinal hole and a through hole (178) arranged opposite the longitudinal slit;  
 a sleeve (202) arranged to reciprocally slide over the connector between two end positions, having a first end facing the tool bit and a second end facing the tool mount, a stepped inside diameter, having a smaller diameter part facing the power tool or hand tool, and a larger diameter part facing the tool bit;  
 a sleeve biasing means (201) arranged to bias the sleeve away from the tool mount;  
 a substantially circular washer (176), having a short radial protrusion (161) and a long radial protrusion (162) opposite to the first protrusion, the washer being arranged to reciprocally slide or tilt in the enlargement of the longitudinal hole, the washer further having a central hole (179), which has a cross-section shape corresponding to and accommodating the cross-section of the tool bit, the first protrusion being insertable into the through hole and the second protrusion being insertable into the slit, the sleeve being biased away from the tool mount by the sleeve biasing means, which presses on the sleeve via the second protrusion of the washer, the outside diameter of the washer being smaller than the inside diameter of the enlargement of the longitudinal hole, allowing the washer to tilt inside the enlargement, the washer being prevented from tilting excessively in the enlargement of the longitudinal hole by the first protrusion cooperating with the through hole and the second protrusion cooperating with the slit.



10. A holder according to claim 9, wherein the cross-section shape of the washer is hexagonal.
11. A holder according to claim 9, wherein the cross-section shape of the washer is oval.
12. A holder according to claim 9, wherein the cross-section shape of the washer is square.
13. A holder according to claim 9, wherein the cross-section shape of the washer is rectangular.
14. A holder according to claim 9, wherein the tool bit is a double-ended tool bit having a first tool type (306) at one end and a second tool type (307) at the opposite end.
15. A holder (100'') for holding a tool bit, the holder comprising:  
an elongate connector (114'') attachable to a power tool/hand tool via a tool mount (10<sup>v</sup>), the connector having a longitudinal hole with a cross-section corresponding to the cross-section of a mounting portion of the tool bit and a first radial hole (750) running from an outside surface of the connector to the longitudinal hole;  
an elongate rocker arm (700) pivotably arranged in the first radial hole, a first end (710) of the rocker arm cooperating with a circumferential groove (305) of the tool bit to lock the tool bit in place when the tool bit is fully inserted into the holder, a second end (720) having a stop surface which contacts the tool bit when the first end is pivoted away from the circumferential groove;  
a sleeve (184'') arranged to reciprocally slide over the connector between two end positions, having a first end facing the tool bit and a second end facing the hand tool, a stepped inside diameter, having a smaller diameter part facing the power tool or hand tool, and a larger diameter part facing the tool bit, and a bevelled transition (186'') arranged between the smaller diameter part and the larger diameter part;

a sleeve biasing means (360''') arranged to bias the sleeve towards the tool mount, the bevelled transition being arranged to cooperate with the second end of the rocker arm by pressing against the second end by the sleeve biasing means;

a mechanism for holding the sleeve in its end positions, comprising a locking cavity (364'), which cooperates with a locking ring (362') arranged in a locking ring groove (363') arranged on the connector to limit the stroke of the sliding movement of the sleeve along the connector, by either edge of the locking cavity contacting the sides of the locking ring to provide the blocking of the sleeve, the sleeve having a stepped inside diameter, with a smaller diameter part facing the handle and a larger diameter part facing the tool bit, and a middle diameter part arranged between the smaller and the larger diameter parts, the middle diameter part having a diameter which is larger than the diameter of the small diameter part but smaller than the diameter of the large diameter part, and being arranged to house the sleeve biasing means, the bevelled transition being arranged between the large and middle diameter parts.

15

16. A holder according to claim 15, wherein the tool bit is a double-ended tool bit having a first tool type (306) at one end and a second tool type (307) at the opposite end.

20

17. A holder according to claim 15, wherein the rocker arm has an outwardly protruding transition part (721), which is cooperating with a second slanted part (122'') of the sleeve to press the first end of the rocker arm into a tool bit groove (330) when the tool bit is fully inserted into the longitudinal hole of the connector.

25

18. A holder (100'') for holding a tool bit, the holder comprising:

an elongate connector (114'') attachable to a power tool/hand tool via a tool mount (10''), the connector having a longitudinal hole with a cross-section corresponding to the cross-section of a mounting portion of the tool bit and a first radial hole running from an outside surface of the connector to the longitudinal hole, the first radial hole (830) having a large diameter bore portion at the outside surface of the connector and a small diameter bore portion at the longitudinal hole;

30

a substantially cylindrical locking bar (800) movably arranged in the first radial hole, cooperating with the shape of the first radial hole, the locking bar cooperating with a circumferential groove (305) in the tool bit to lock the tool bit in place when the tool bit is fully inserted into the holder;

5 a sleeve (184'') arranged to reciprocally slide over the connector between two end positions, having a first end facing the tool bit and a second end facing the hand tool, a stepped inside diameter, having a smaller diameter part facing the power tool or hand tool, and a larger diameter part facing the tool bit, and a bevelled transition (186'') arranged between the smaller diameter part and the larger diameter part;

10 a sleeve biasing means (360'') arranged to bias the sleeve towards the tool mount;

a substantially cylindrical transition bar (810) arranged in a transition hole (840) in the connector, the transition hole being substantially radial, the transition bar having a diameter substantially corresponding to the diameter of the transition hole and being  
15 slidable between a first position at the bottom of the transition hole, to a second position where the transition bar protrudes from the top of the transition hole towards the sleeve, the bevelled transition being arranged to cooperate with the transition bar by pressing against the transition bar by the sleeve biasing means,

a mechanism for holding the sleeve in its end positions, comprising a locking  
20 cavity (364'), which cooperates with a locking ring (362') arranged in a locking ring groove (363') arranged on the connector to limit the stroke of the sliding movement of the sleeve along the connector, by either edge of the locking cavity contacting the sides of the locking ring to provide the blocking of the sleeve, the sleeve having a stepped inside diameter, with a smaller diameter part facing the handle and a larger diameter part  
25 facing the tool bit, and a middle diameter part arranged between the smaller and the larger diameter parts, the middle diameter part having a diameter which is larger than the diameter of the small diameter part but smaller than the diameter of the large diameter part, and being arranged to house the sleeve biasing means, the bevelled transition being arranged between the large and middle diameter parts.

30

19. A holder according to claim 18, wherein the transition hole is angled, so that the bottom of the transition hole is arranged further from the tool mount than the top of the transition hole.

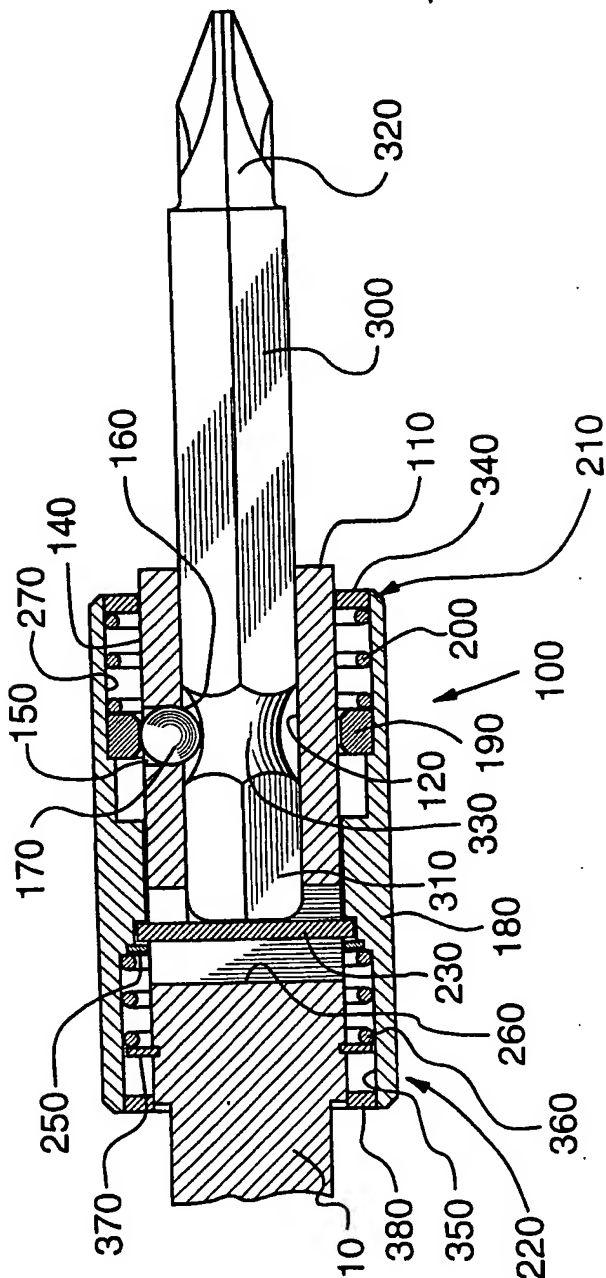
5 20. A holder according to claim 18, wherein the transition hole is substantially perpendicular to the longitudinal hole.

21. A holder according to claim 18, wherein the tool bit is a double-ended tool bit having a first tool type (306) at one end and a second tool type (307) at the opposite  
10 end.

22. A holder (100<sup>IV</sup>) for holding a tool bit, the holder comprising:  
an elongate connector (114<sup>V</sup>) attachable to a power tool/hand tool via a tool mount (10<sup>VI</sup>), the connector having a longitudinal hole (120<sup>VI</sup>) with a cross-section  
15 corresponding to the cross-section of a mounting portion of the tool bit and a first radial hole (830') running from an outside surface of the connector to the longitudinal hole;  
a locking pin (700') movably arranged in the first radial hole, cooperating with a waist portion (308) of the tool bit to lock the tool bit in place when the tool bit is fully inserted into the holder, the locking pin having a slanted first end (701), a slanted second  
20 end (702) and a protruding stop (704) around a middle portion of the locking pin, the protruding stop preventing the locking pin from fully entering the longitudinal hole;  
a sleeve (184<sup>IV</sup>) arranged to reciprocally slide over the connector between two end positions, having a first end facing the tool bit and a second end facing the hand tool, a stepped inside diameter, having a smaller diameter part (192") facing the tool bit  
25 insertion side of the longitudinal hole, and a larger diameter part (193') facing the tool mount, and a bevelled transition (191') arranged between the smaller diameter part and the larger diameter part, the bevelled transition pressing the locking pin towards the longitudinal hole when the sleeve is fully biased towards the tool mount by a sleeve biasing means arranged to bias the sleeve towards the tool mount;  
30 a locking ring (365') arranged in a locking ring groove (363') arranged on the connector to limit the stroke of the sliding movement of the sleeve along the connector.

23. A holder according to claim 22, wherein the tool bit is a double-ended tool bit having a first tool type (306) at one end and a second tool type (307) at the opposite end.
- 5 24. A holder having a quick-connect mechanism actuated by inserting a bit, the bit engaging means to force retraction of a collar, where the collar actuates means for engaging the bit, and released by manual retraction of the collar, generally as described in the preceding.

**FIG. 2**



**FIG. 1**

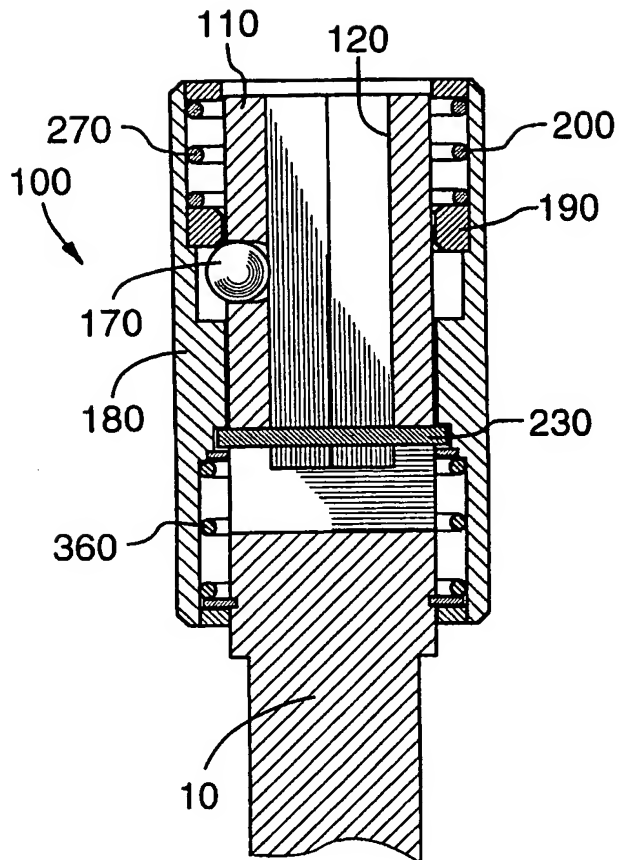


FIG.3

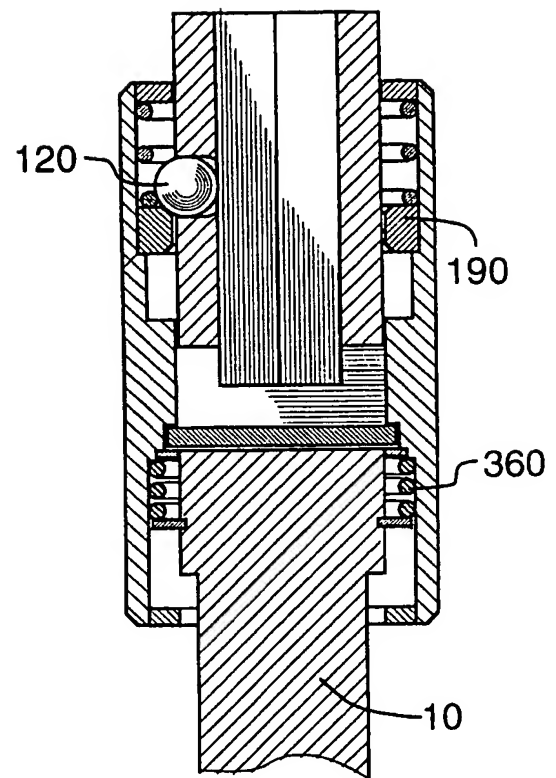


FIG.4

3/60

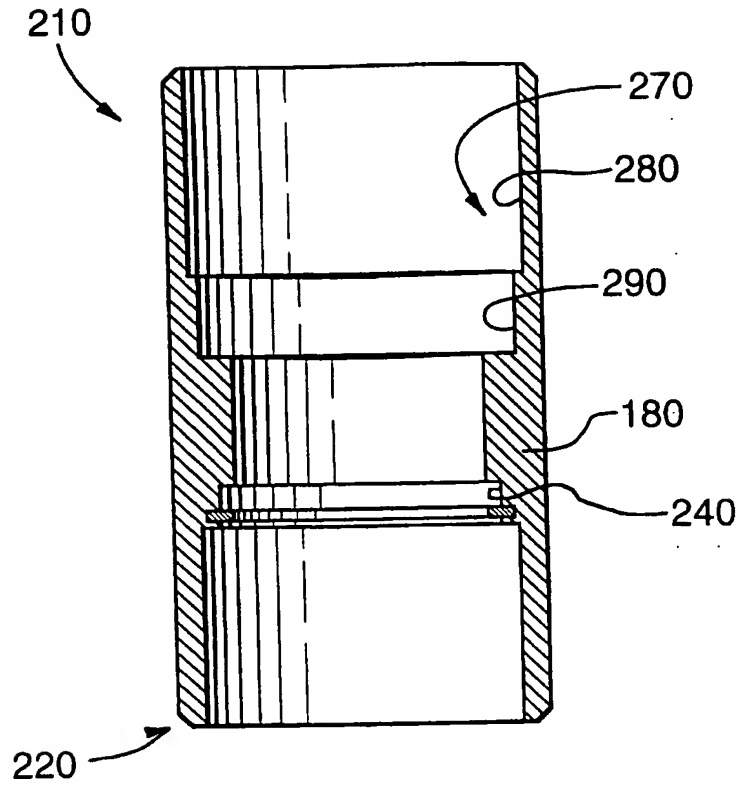


FIG. 5

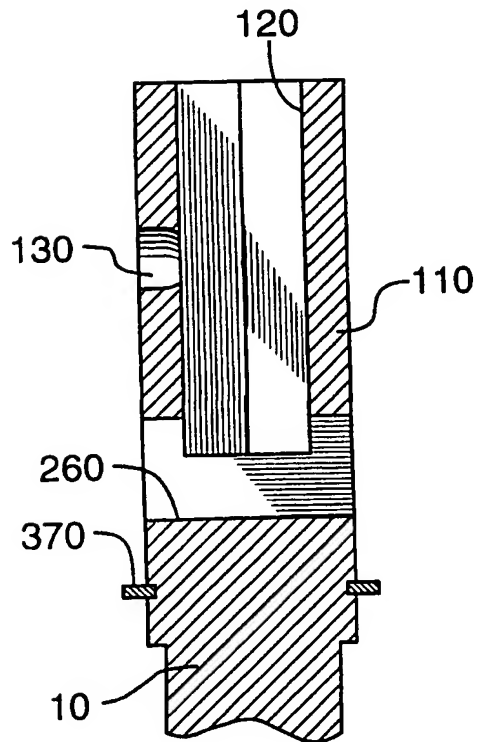


FIG. 6

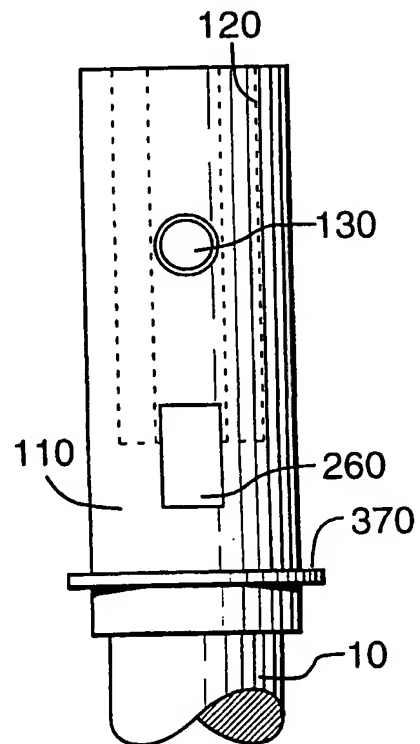


FIG. 7



4/60

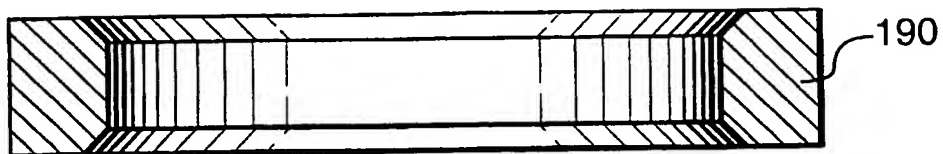


FIG. 8

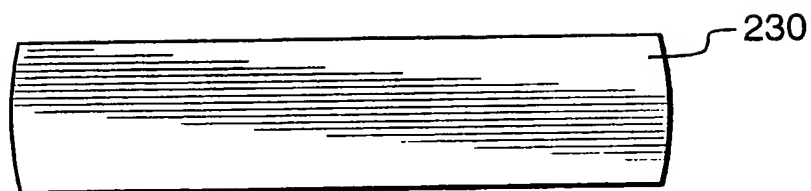


FIG. 9A



FIG. 9B

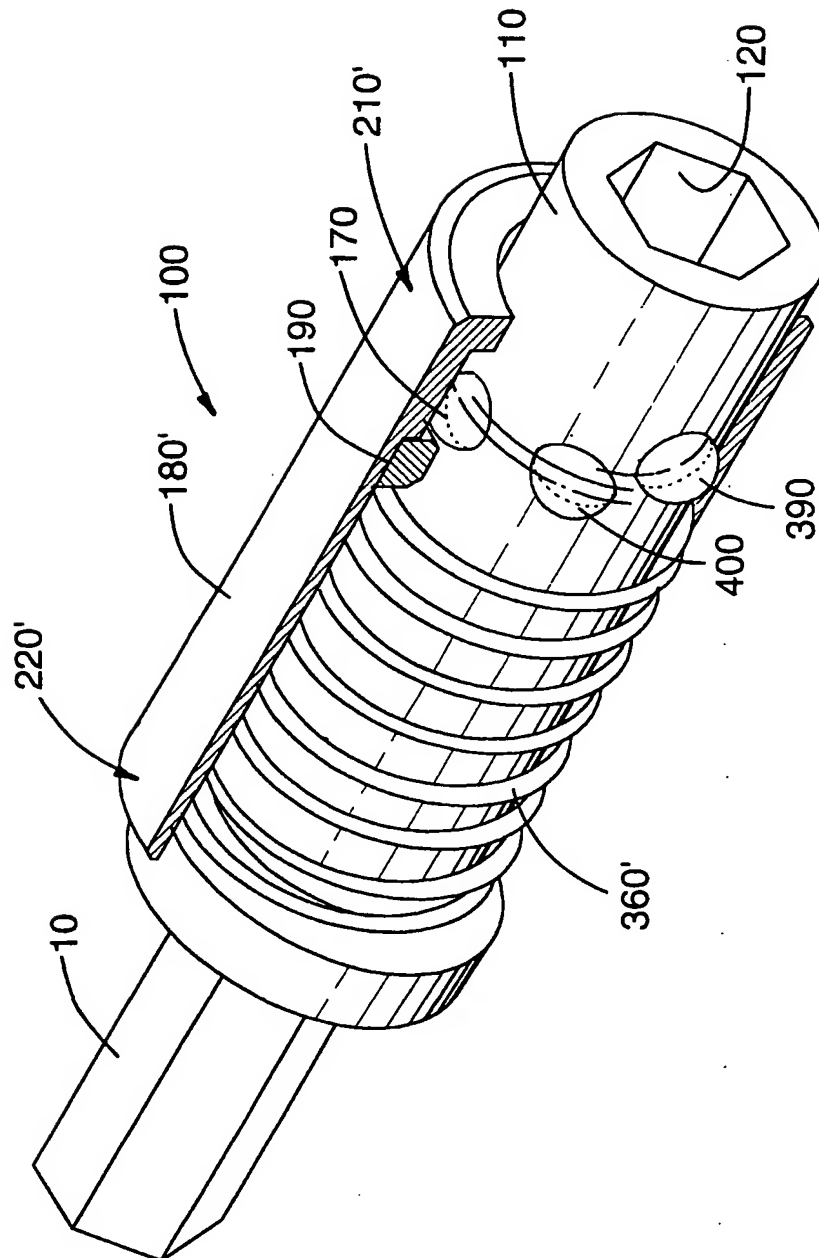


FIG.10

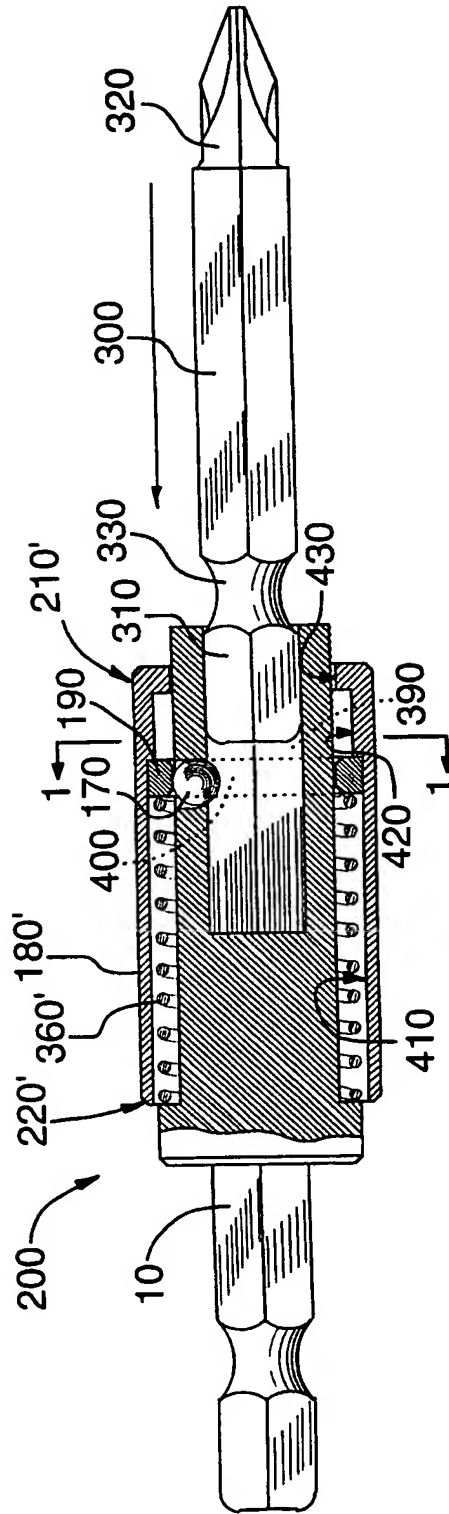


FIG. 11A

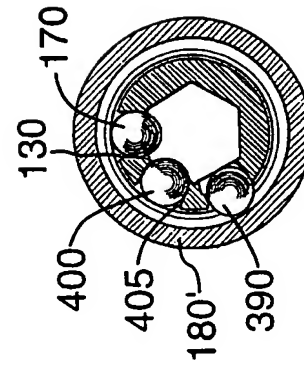


FIG. 11B

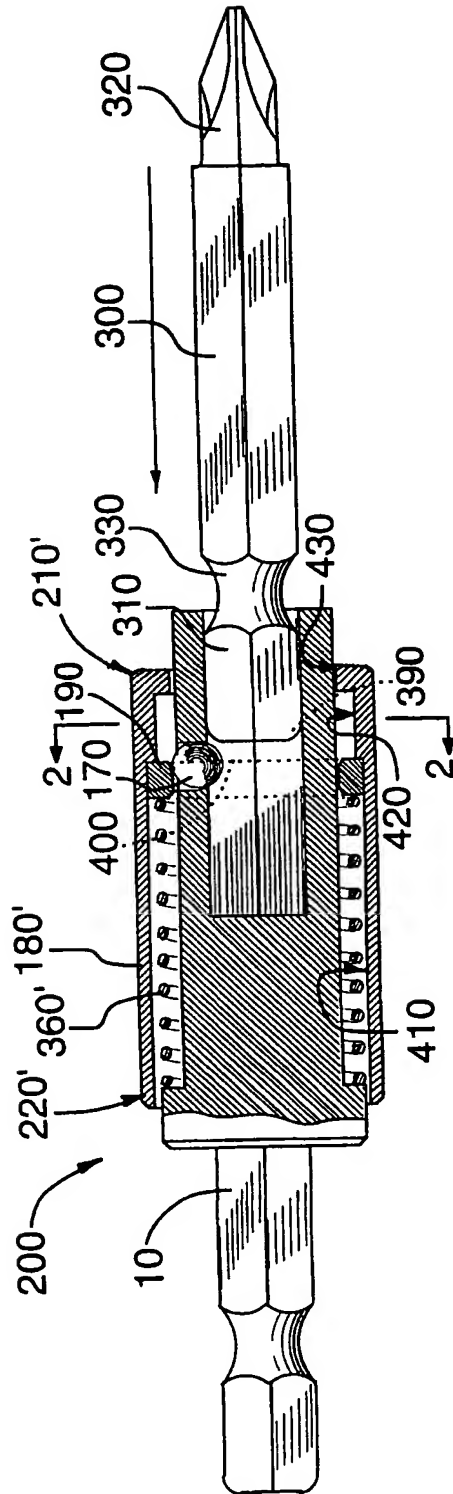


FIG. 12A

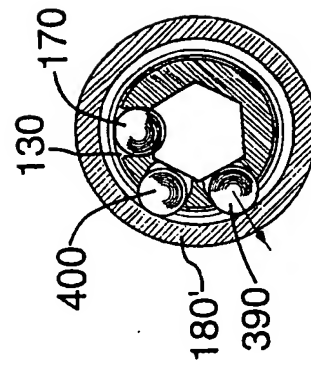


FIG. 12B

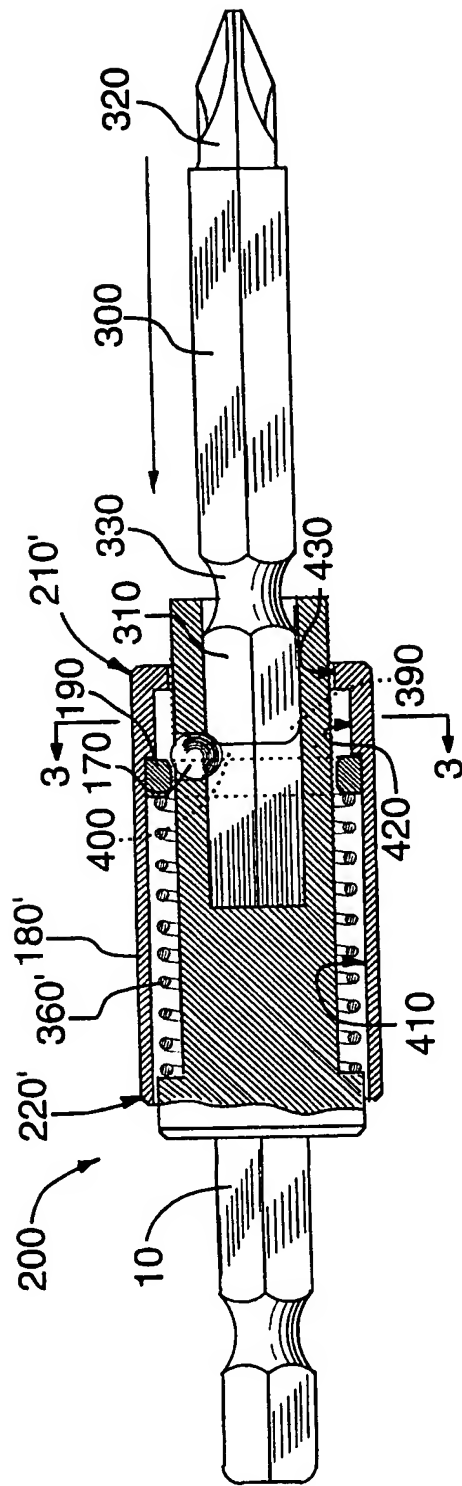


FIG. 13A

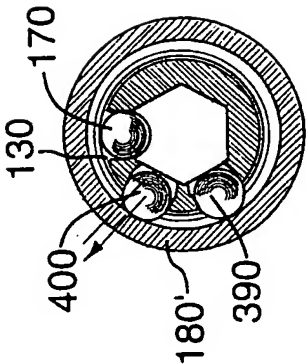


FIG. 13B

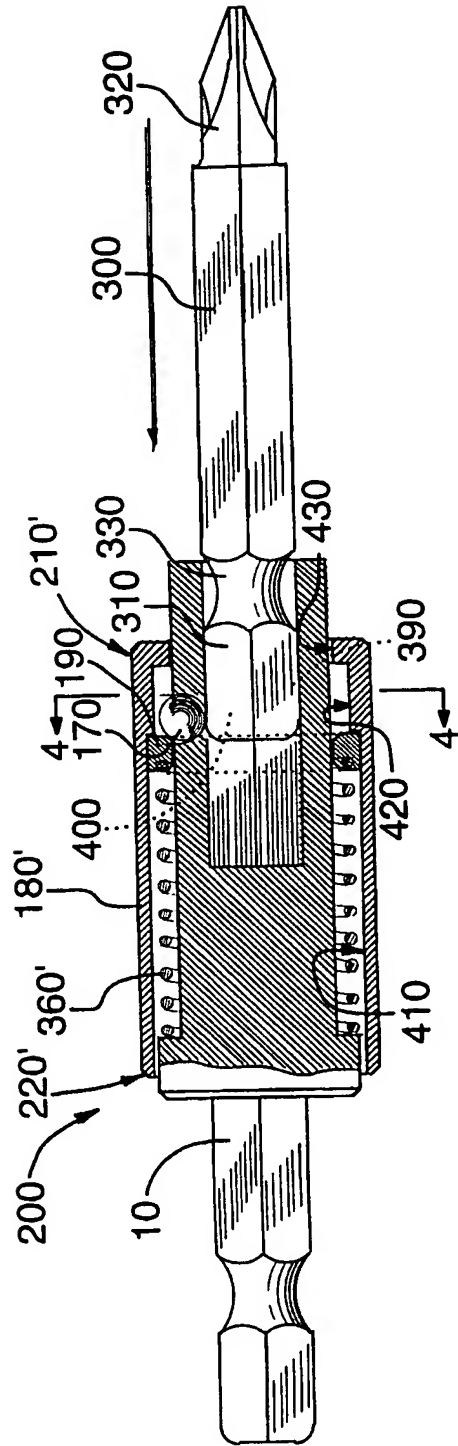


FIG. 14A

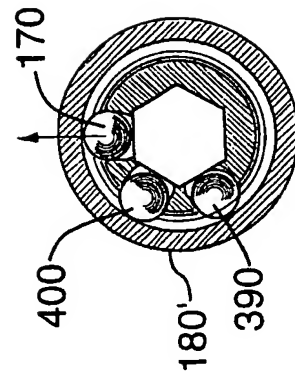
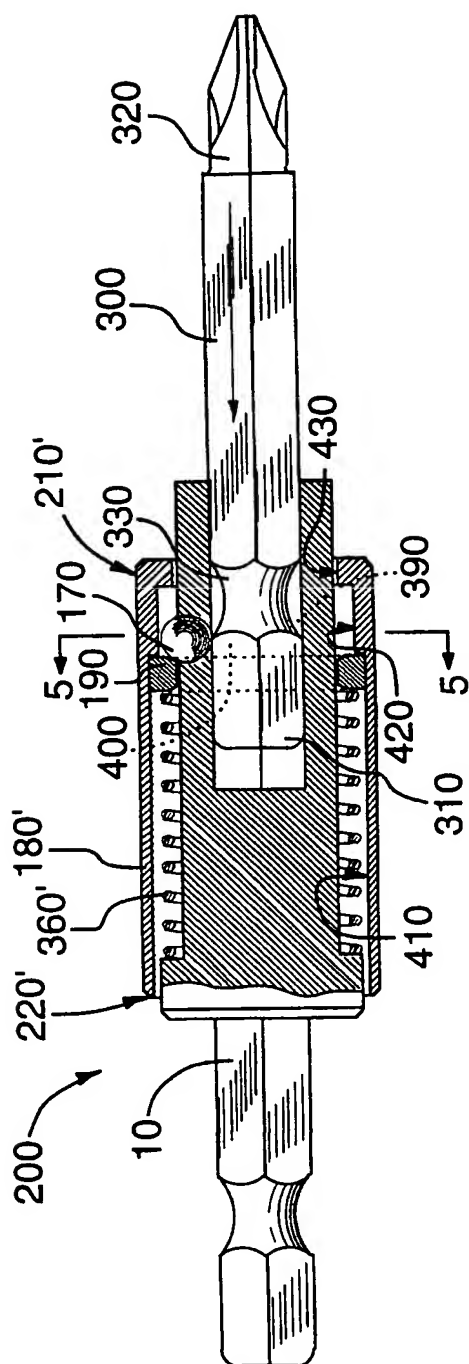
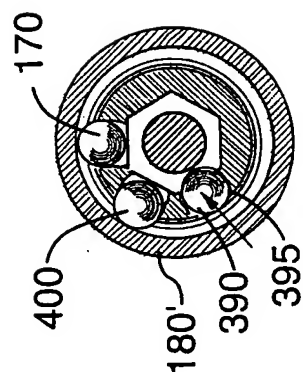


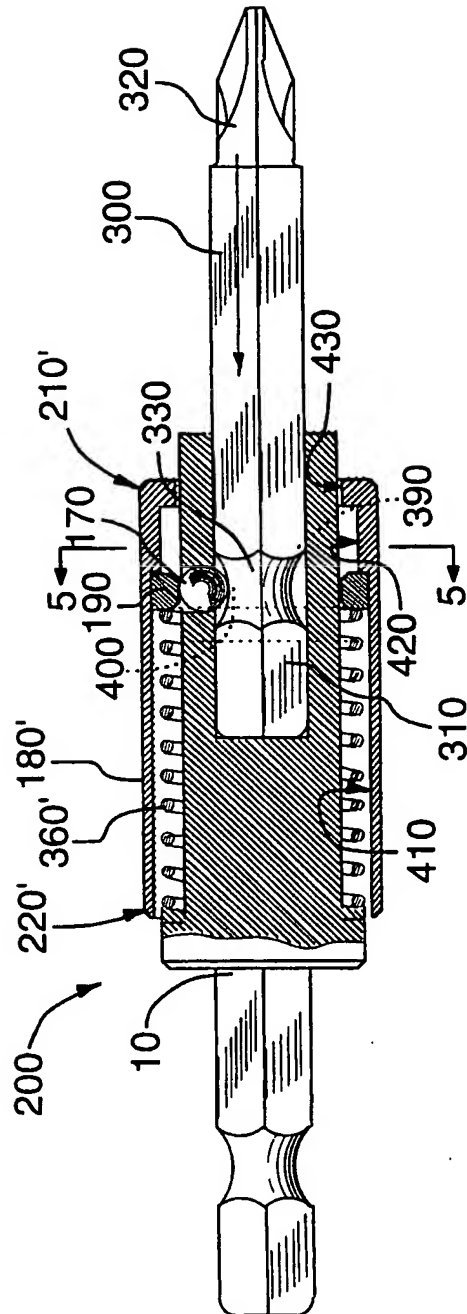
FIG. 14B



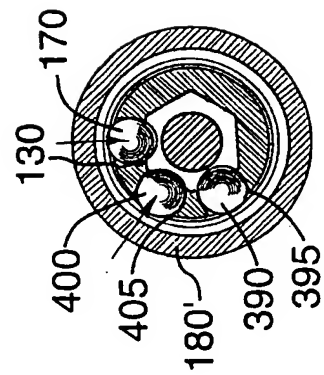
**FIG. 15A**



**FIG. 15B**



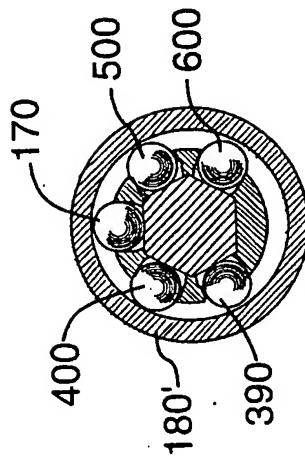
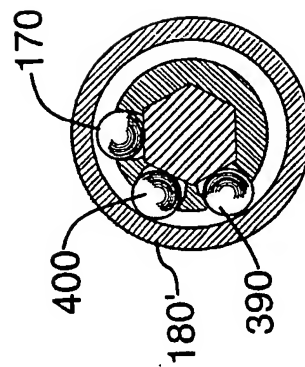
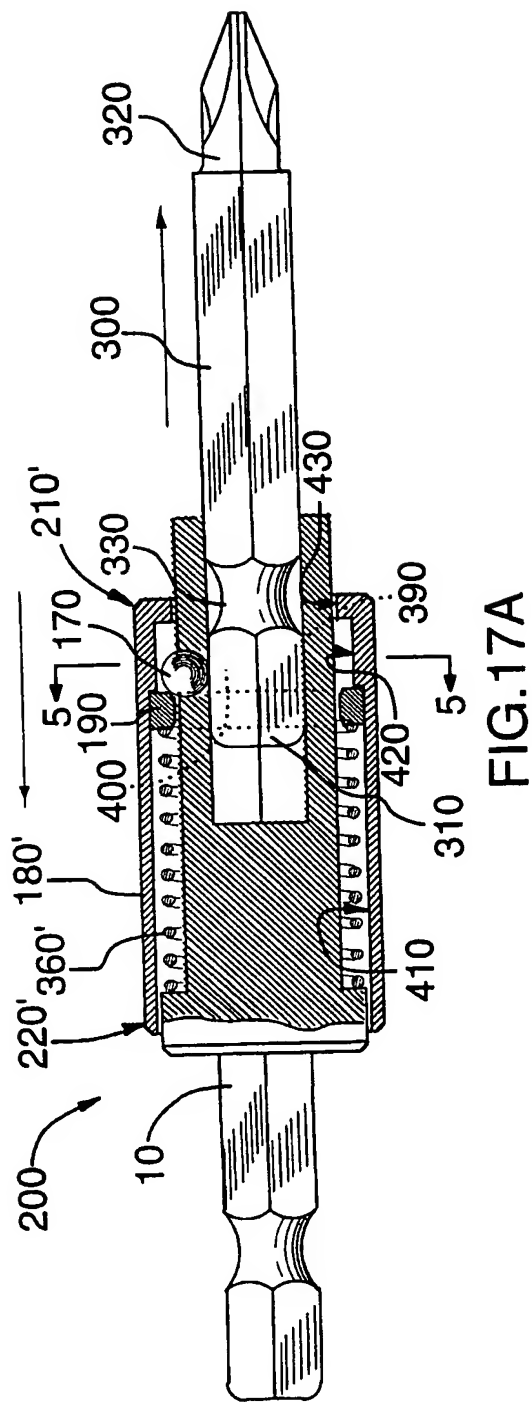
**FIG. 16A**



**FIG. 16B**



12/60



13/60

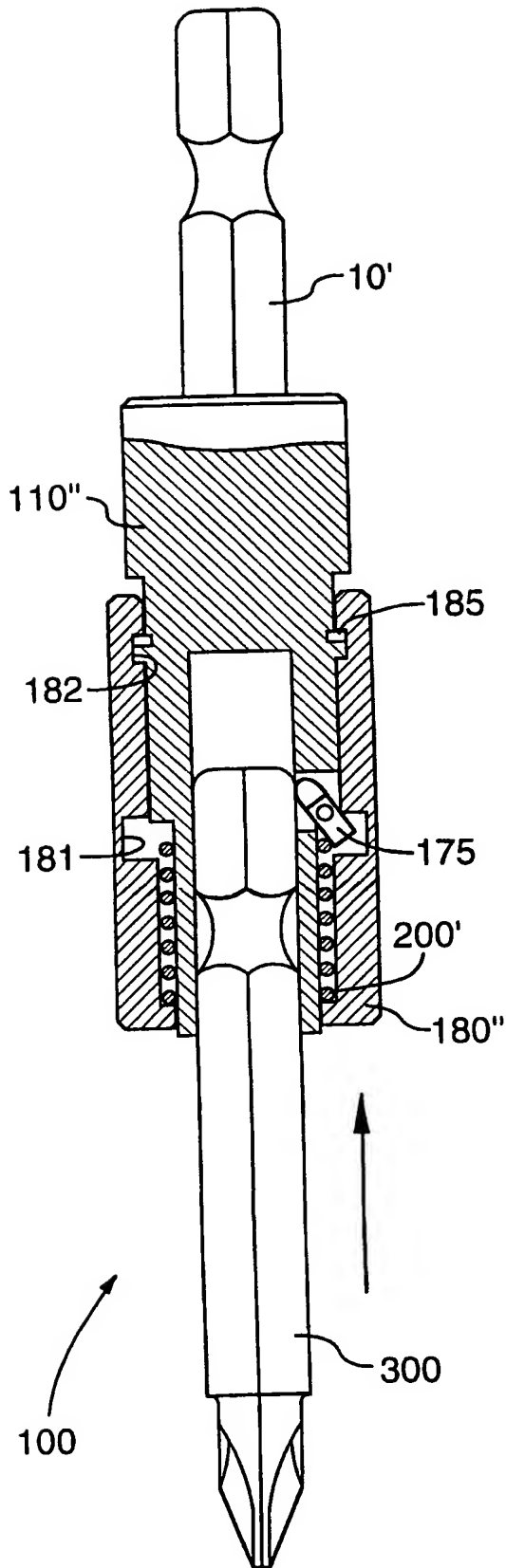


FIG.18

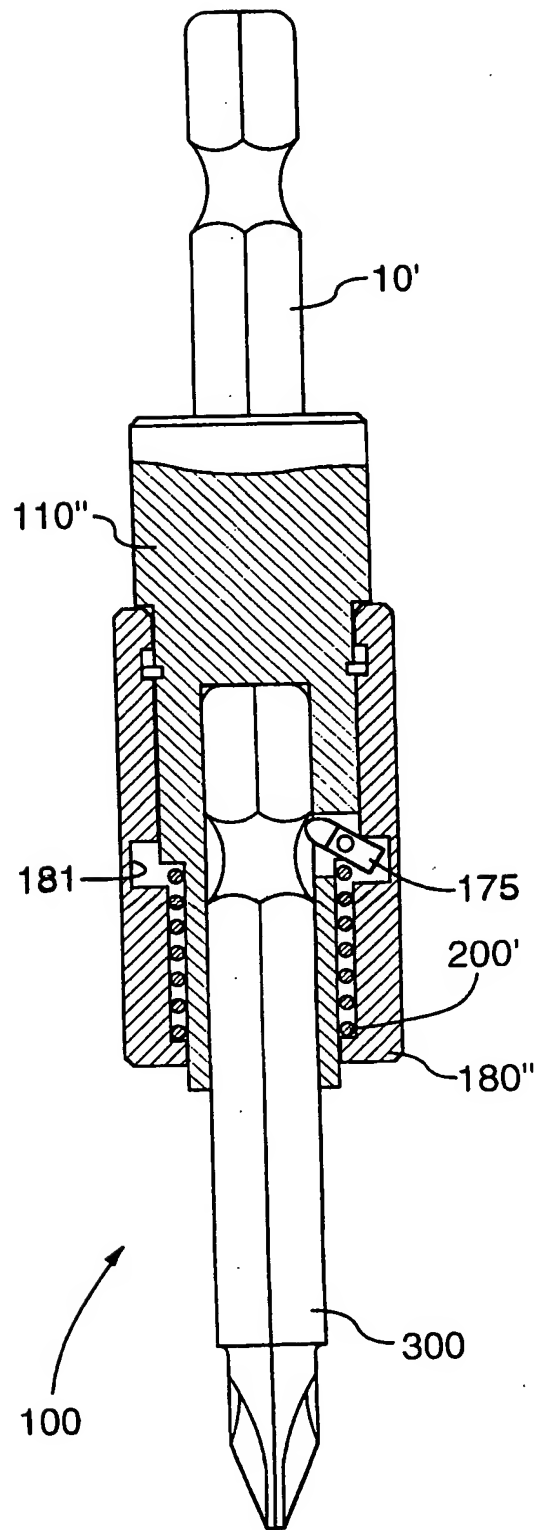


FIG.19

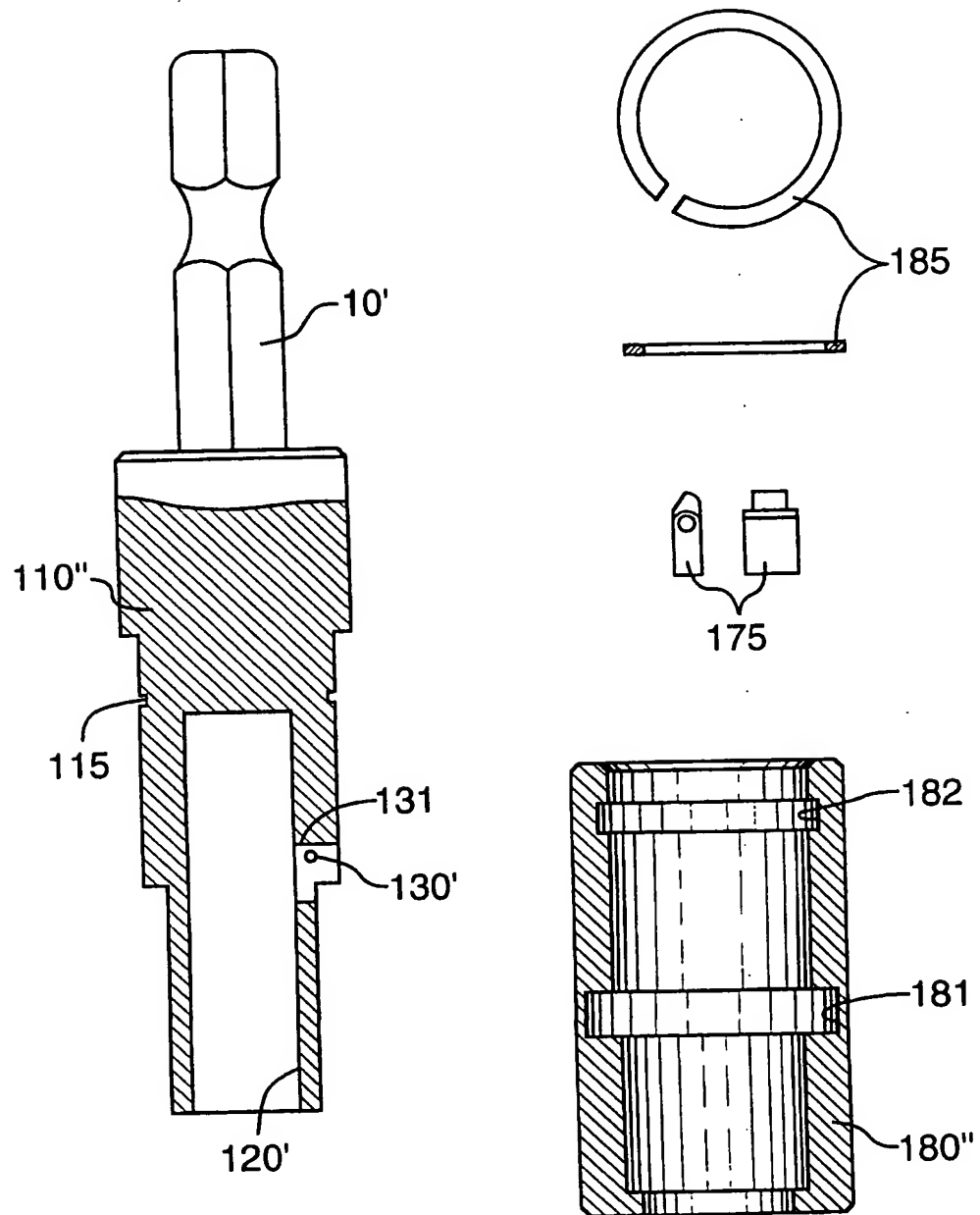


FIG. 20

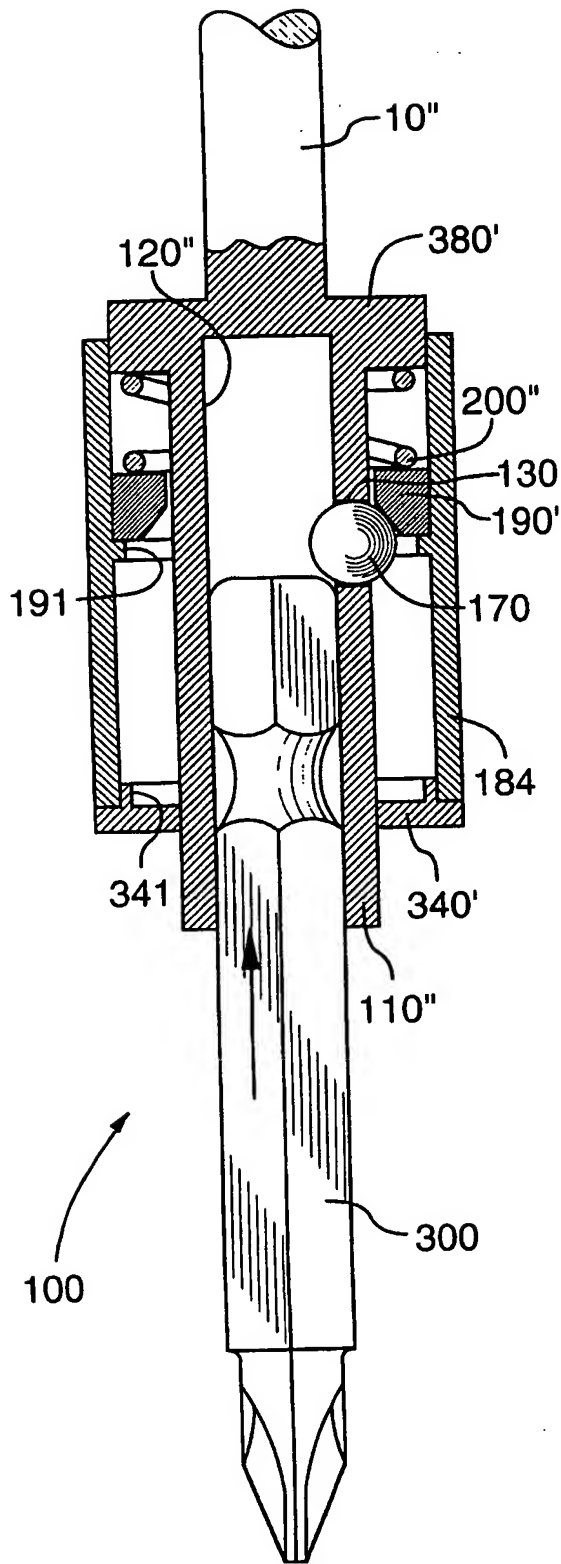


FIG. 21

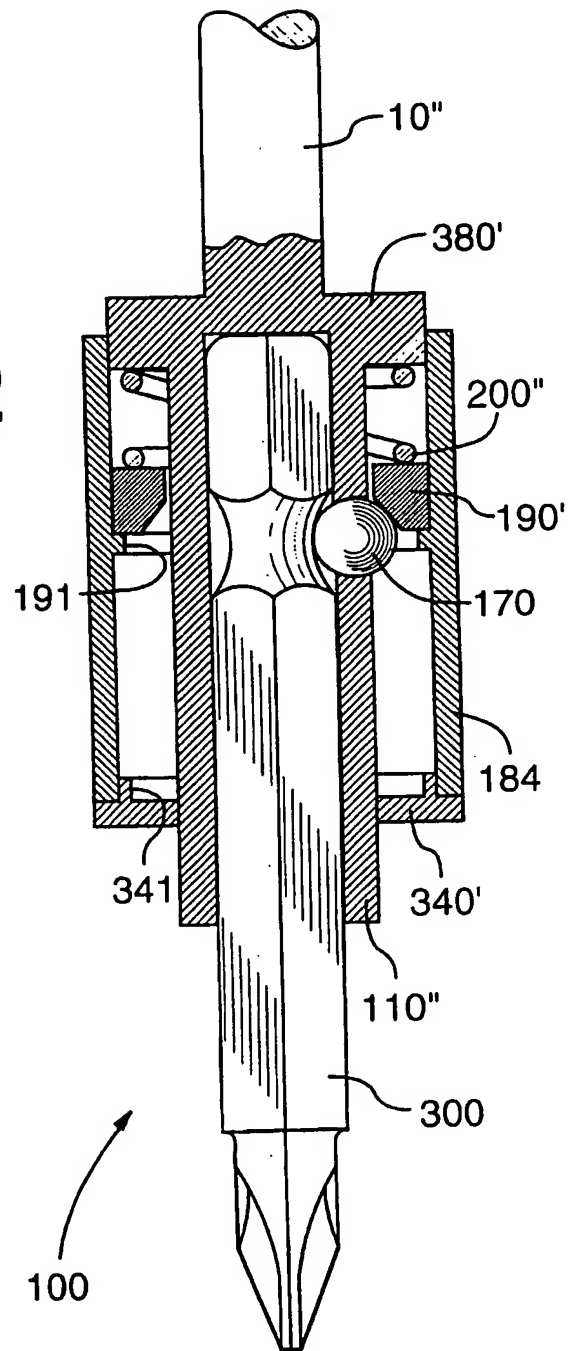


FIG. 22

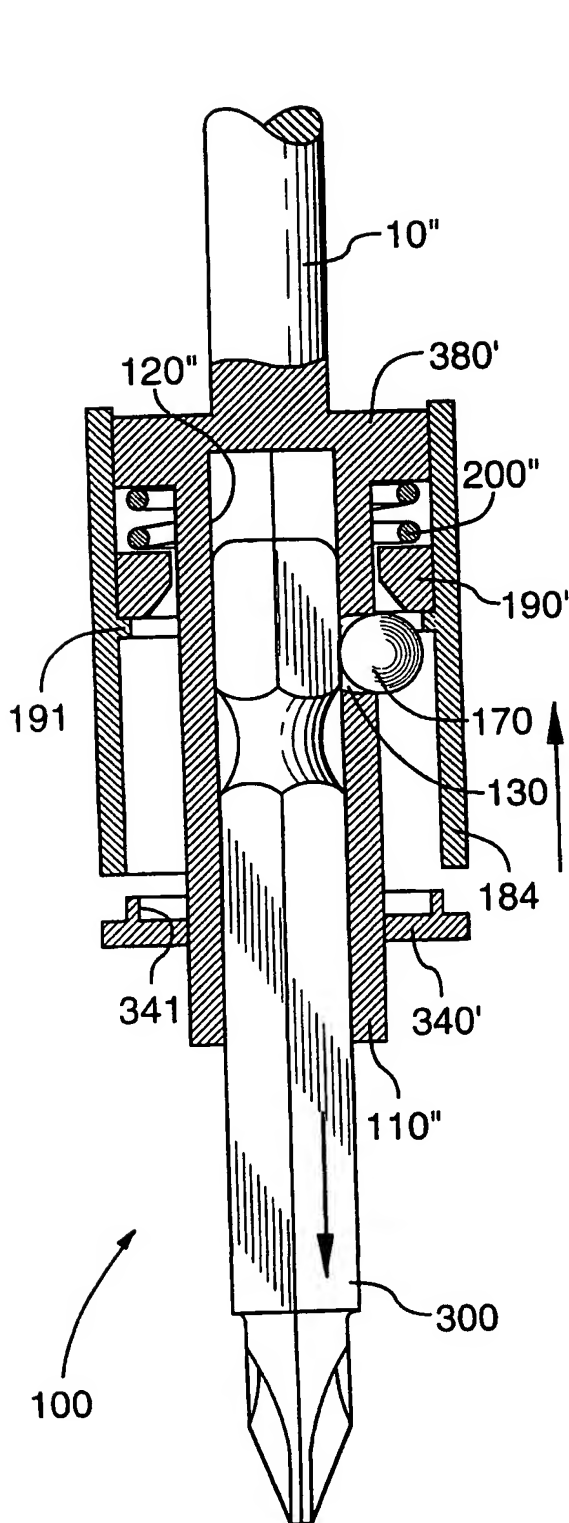


FIG. 23

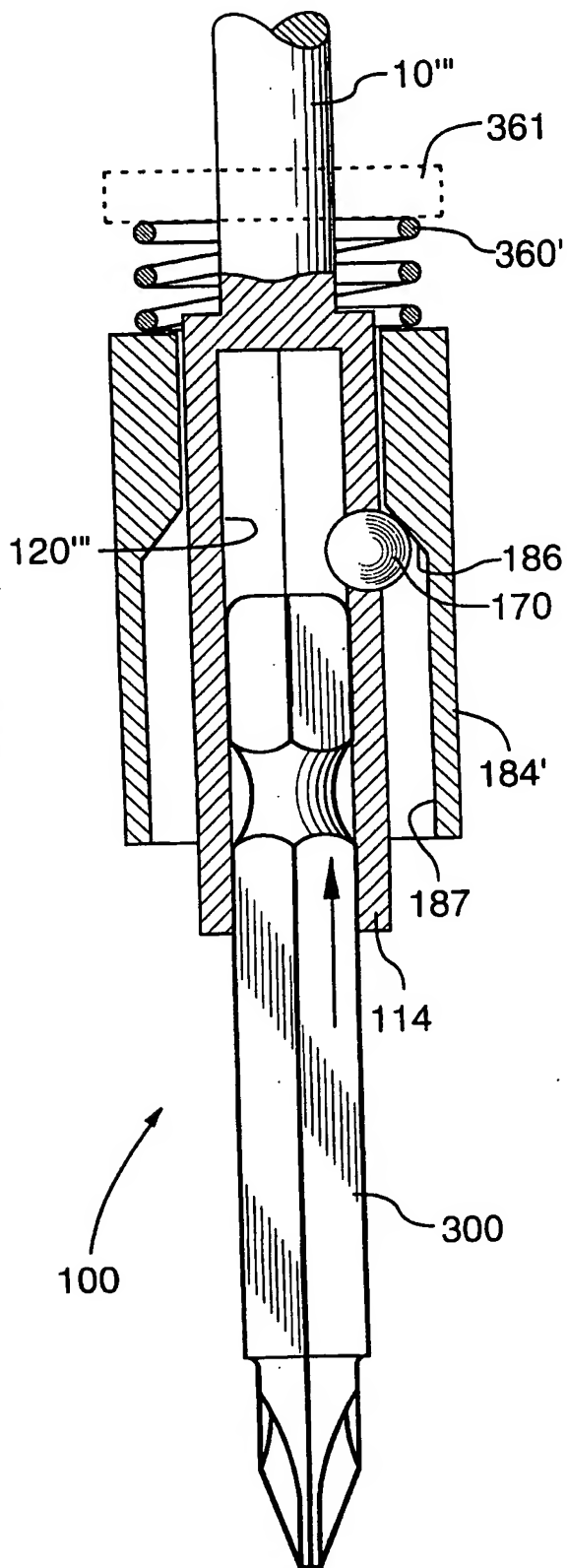


FIG. 24

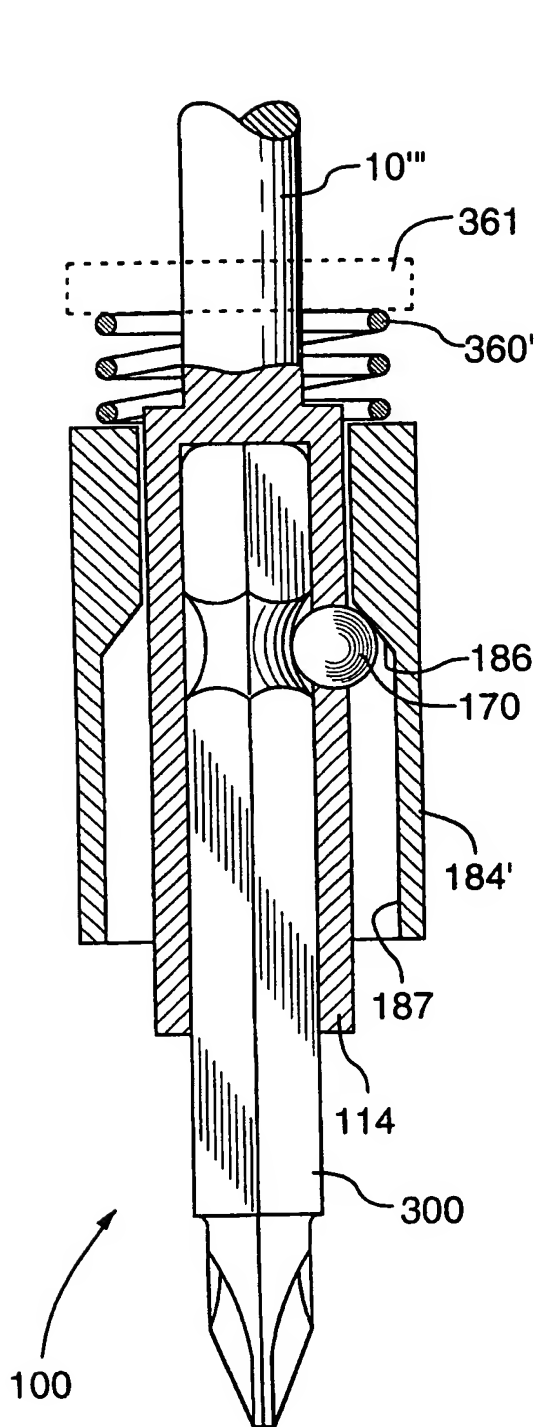


FIG. 25

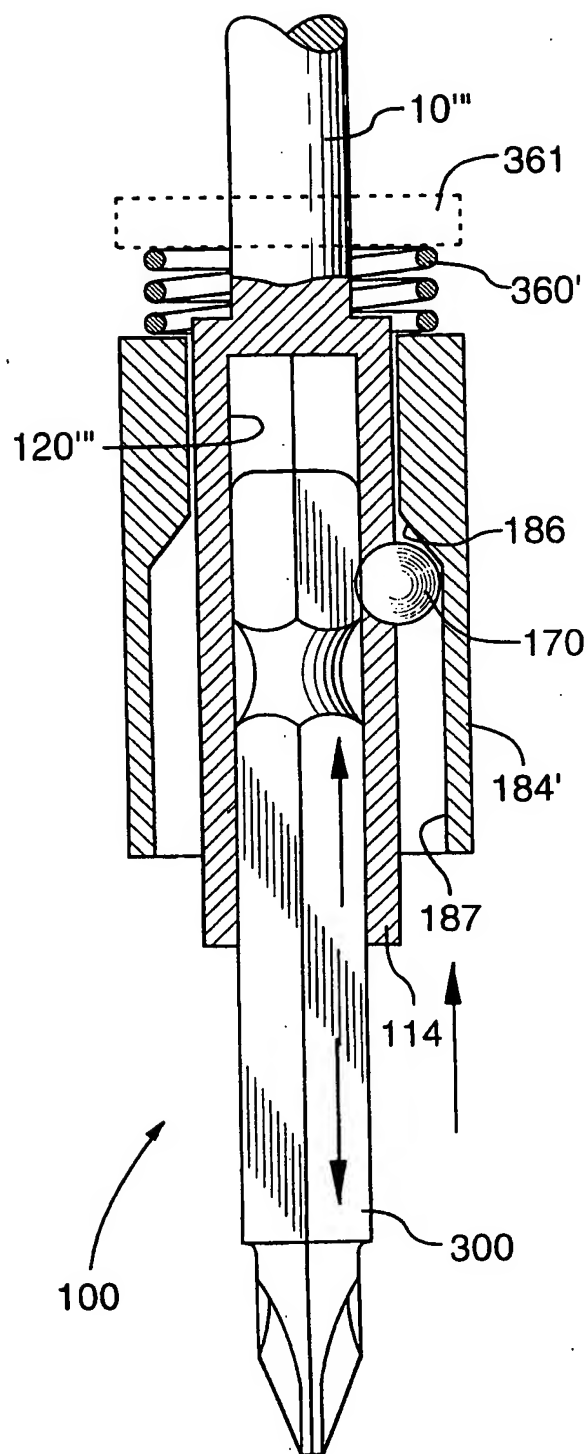


FIG. 26

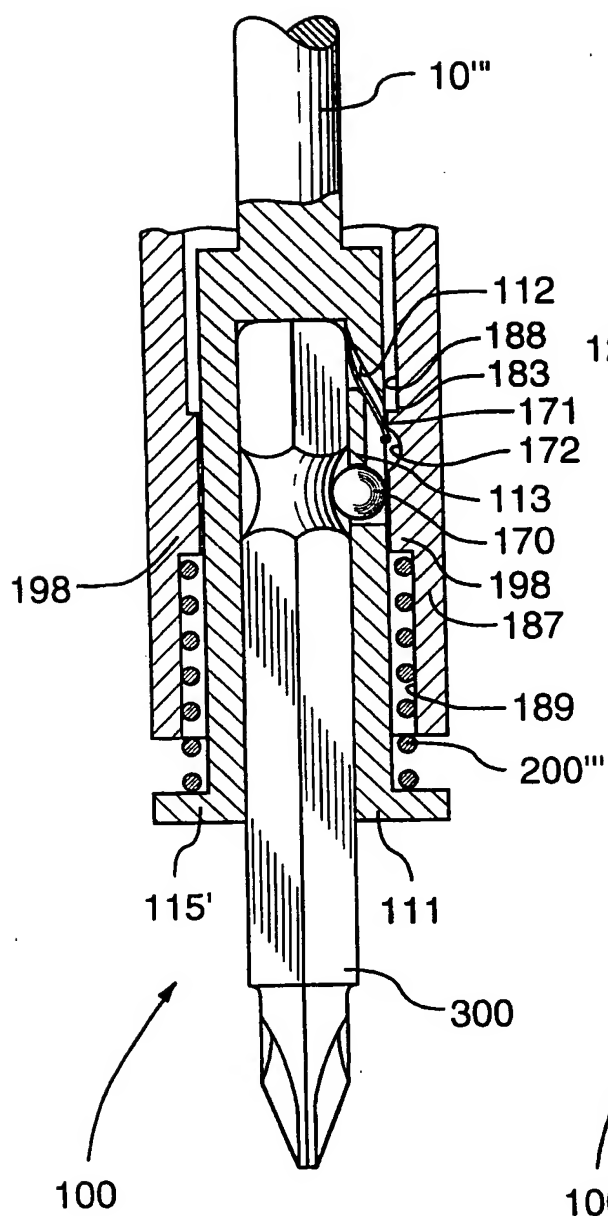


FIG.27

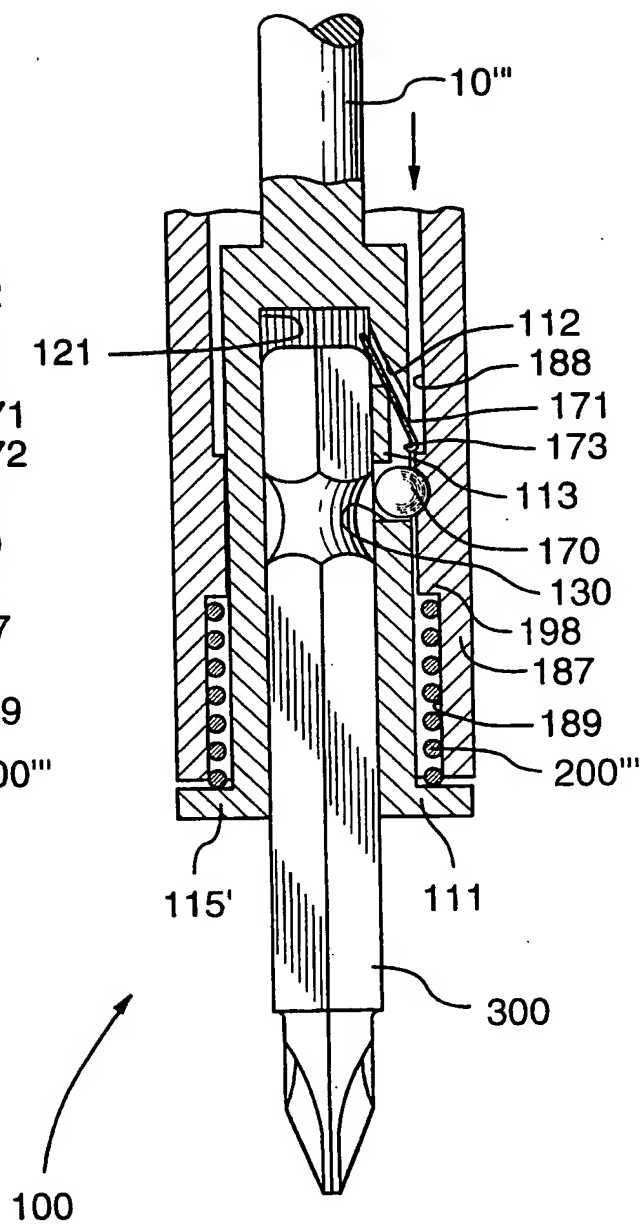


FIG.28

19/60

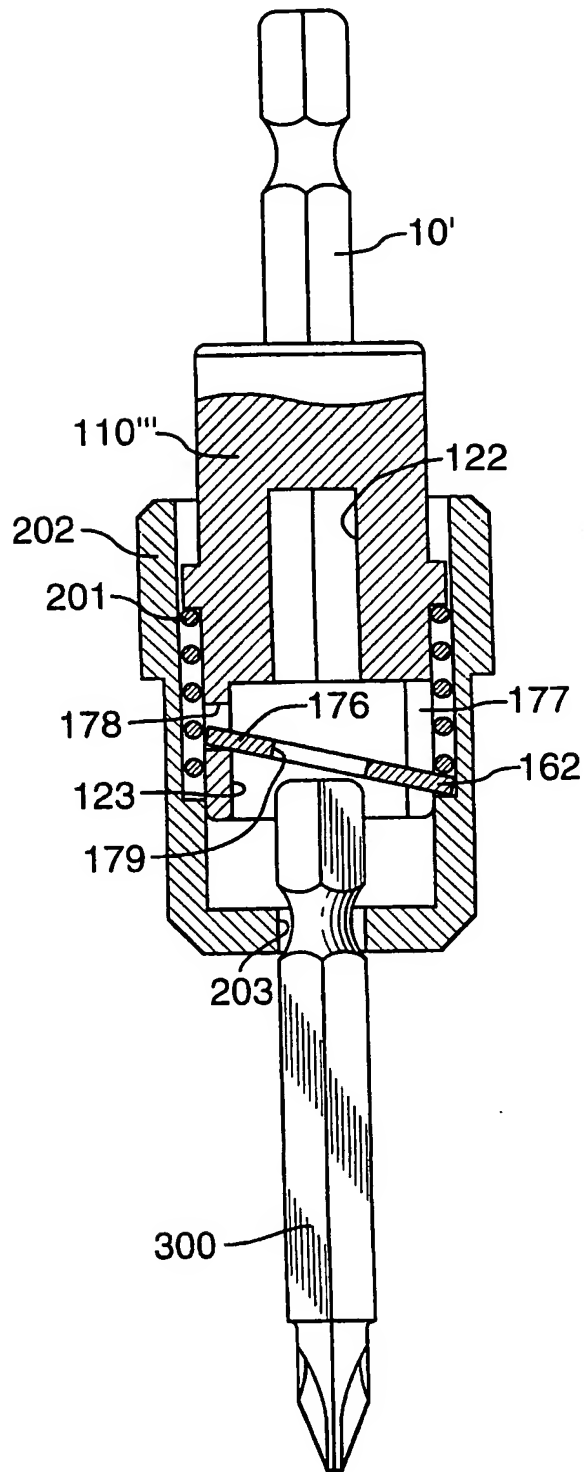


FIG.29



20/60

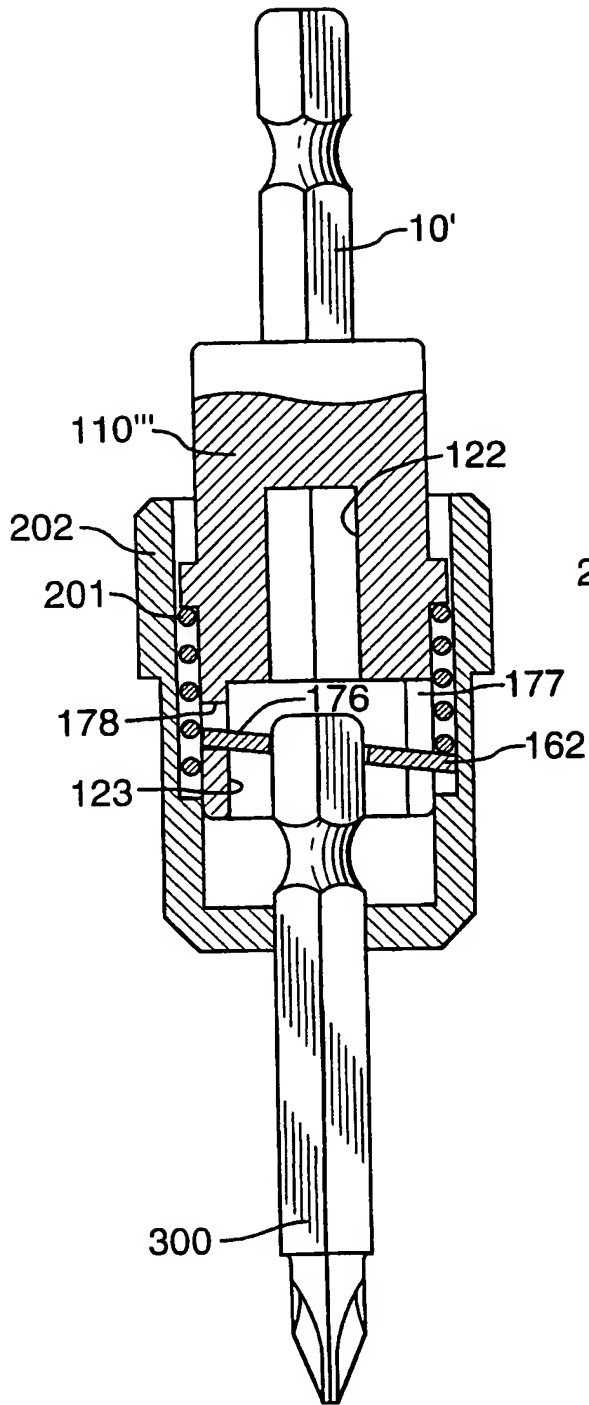


FIG.30

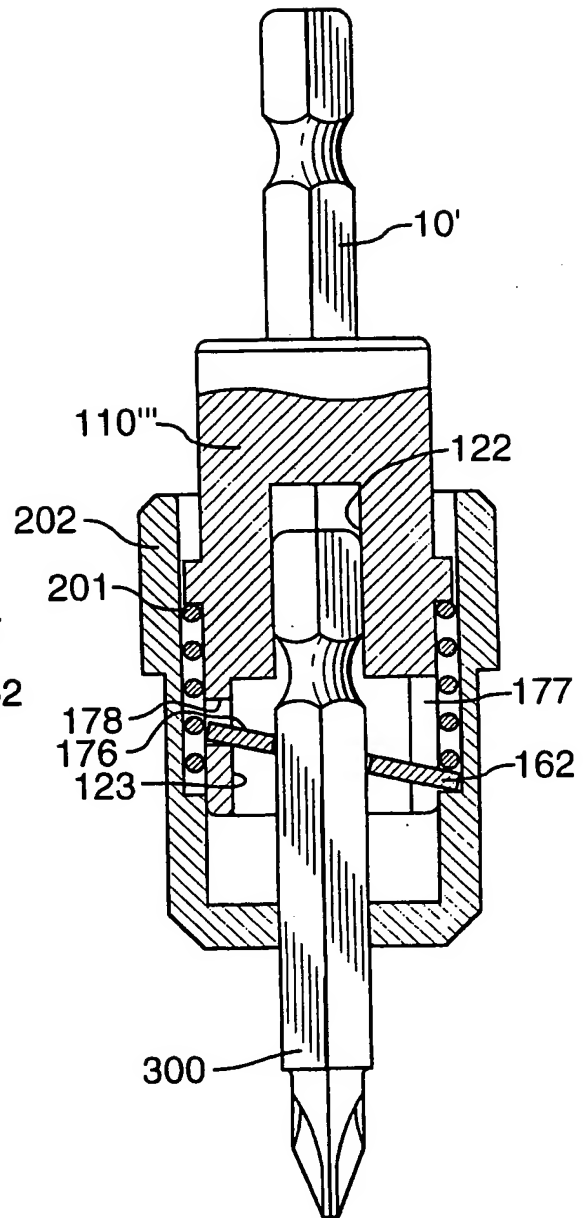


FIG.31

21/60

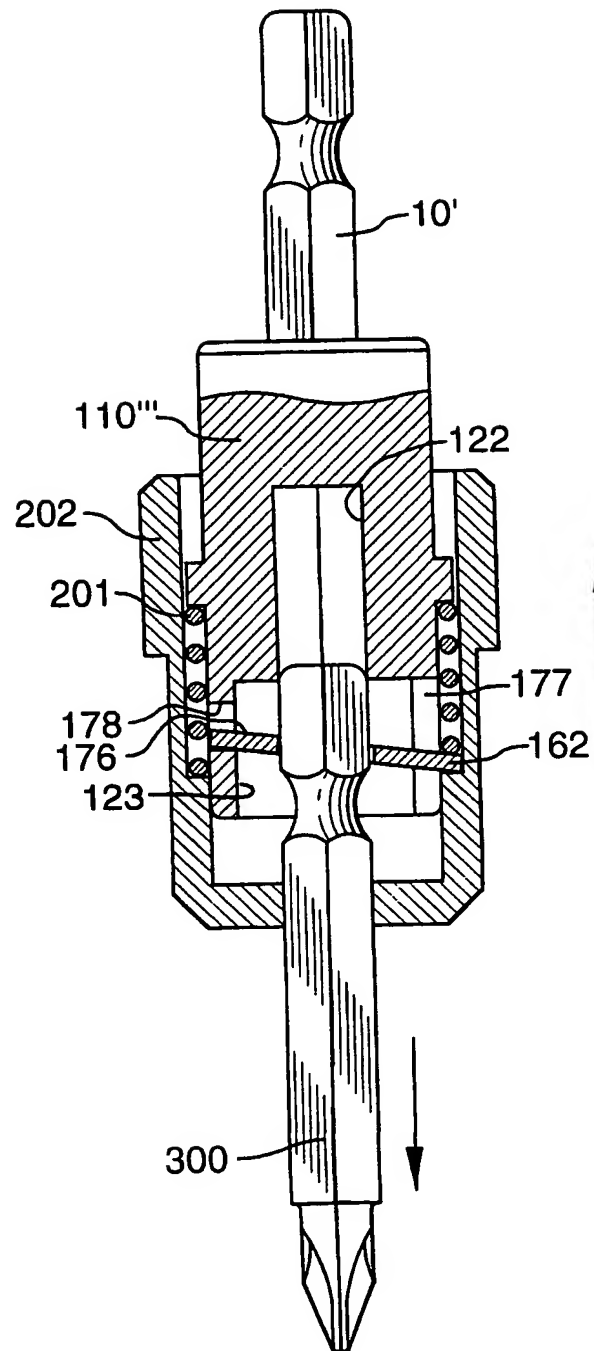


FIG.32

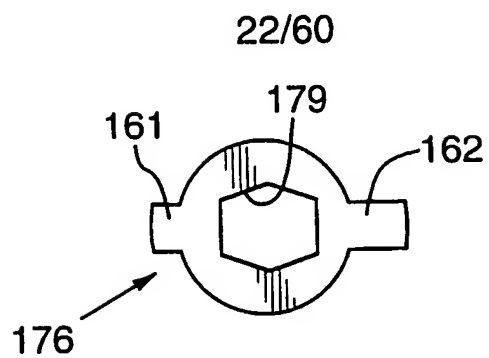


FIG. 33A

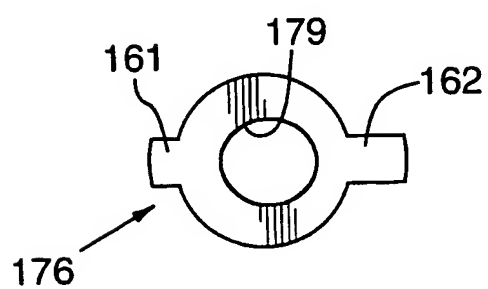


FIG. 33B

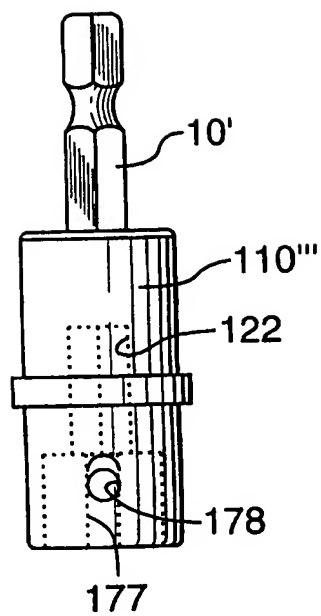


FIG. 34B

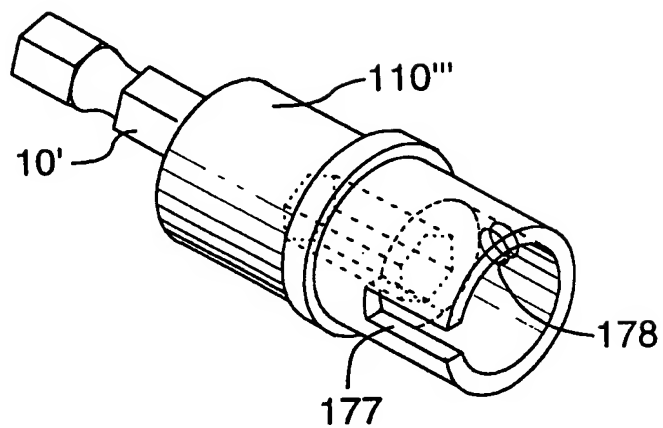


FIG. 34A

23/60

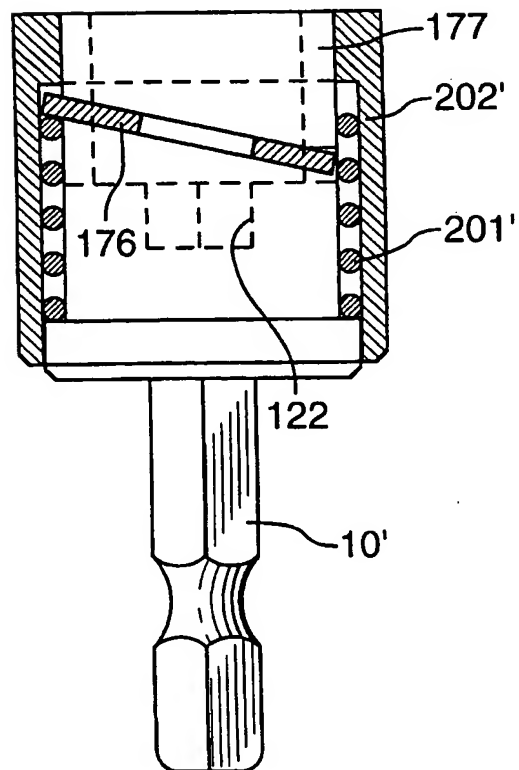
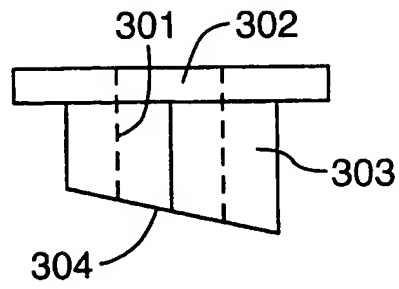


FIG.35

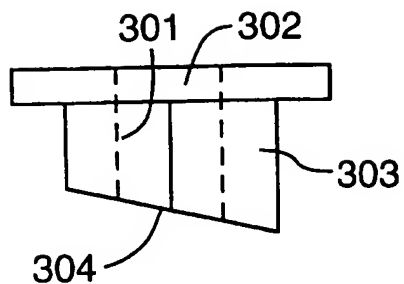


FIG. 36A

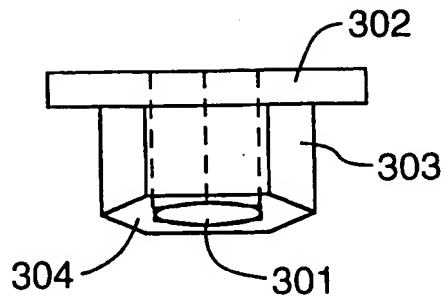


FIG. 36B

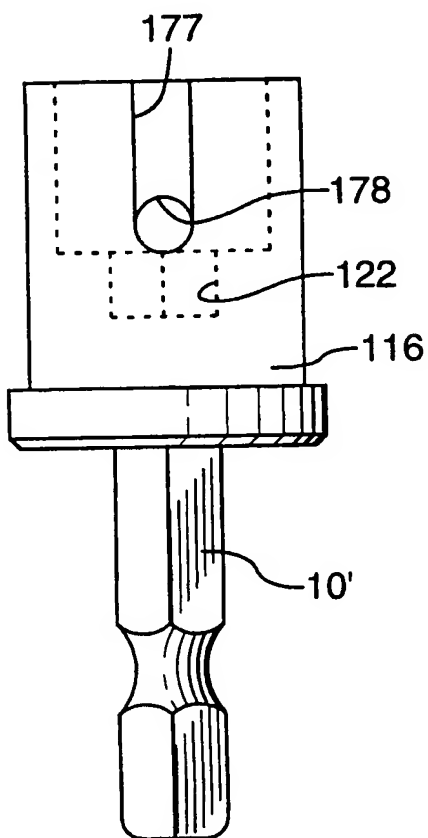


FIG. 37A

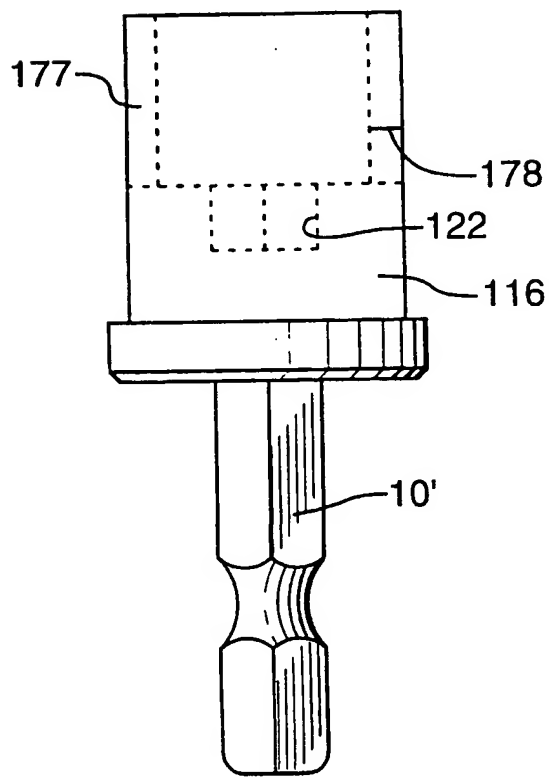


FIG. 37B

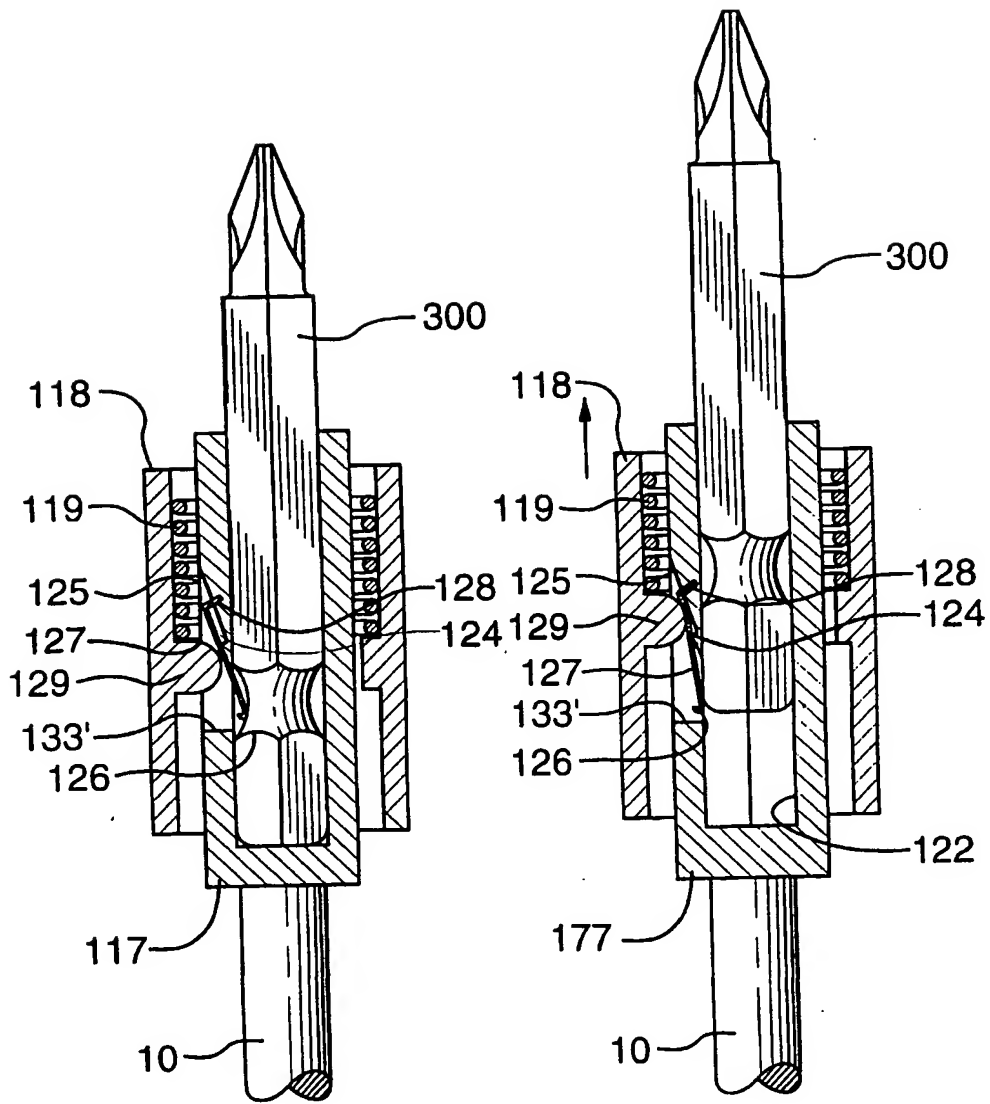


FIG.38A

FIG.38B

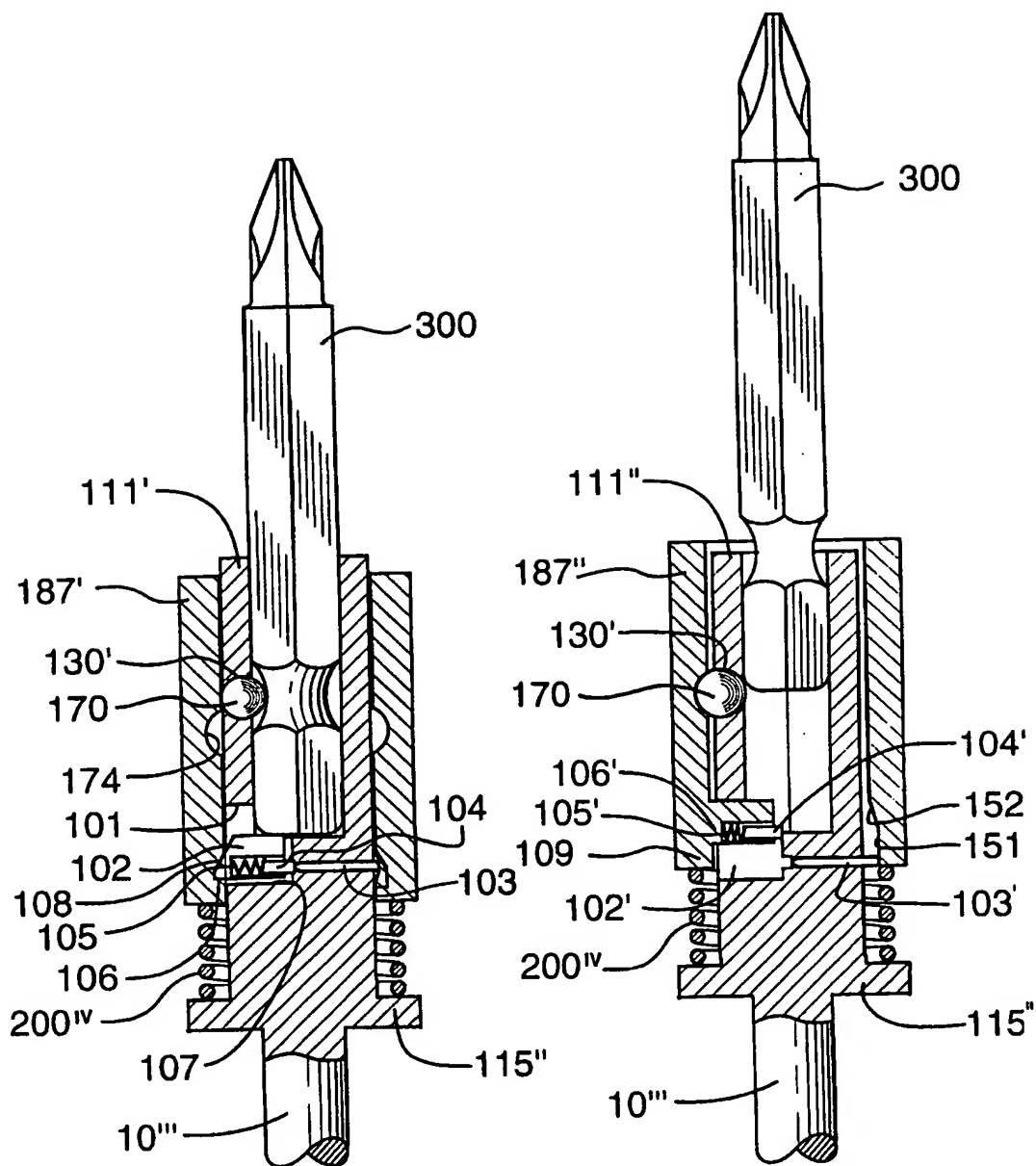


FIG.39A

FIG.39B

27/60

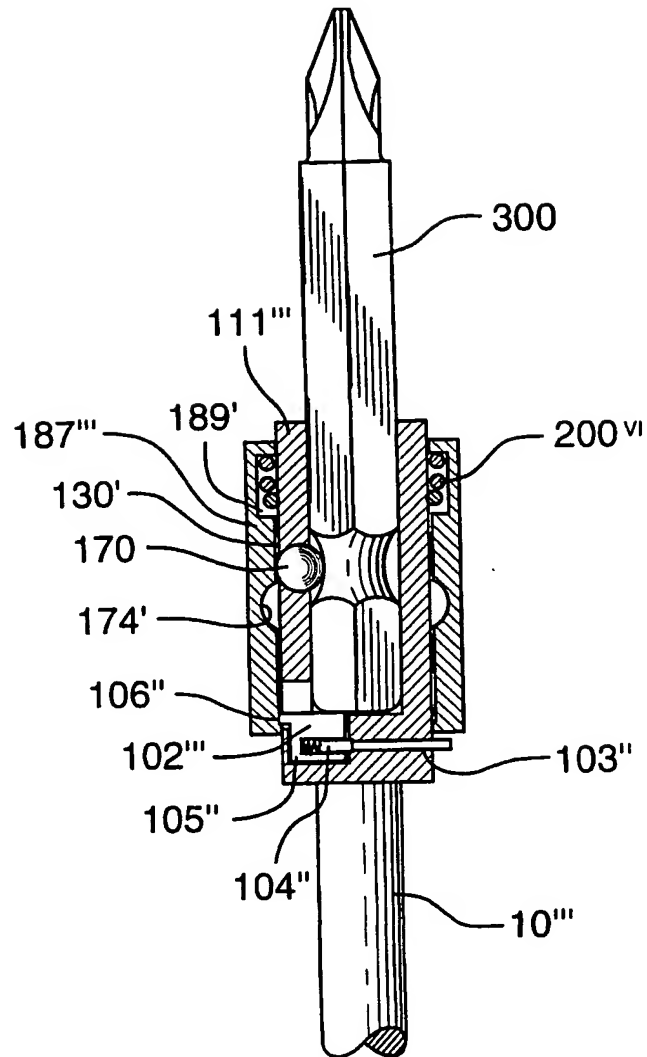


FIG. 39C



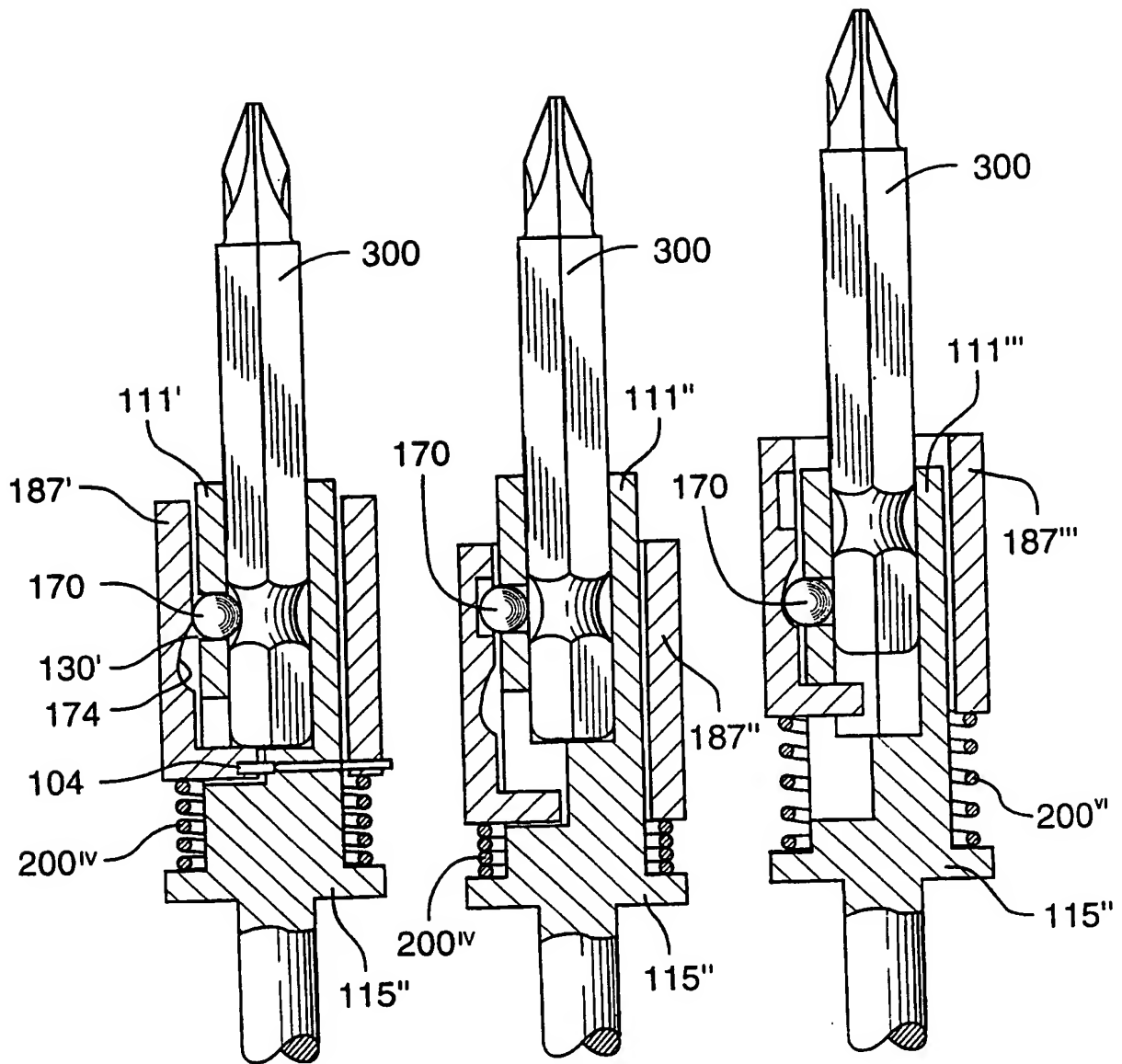
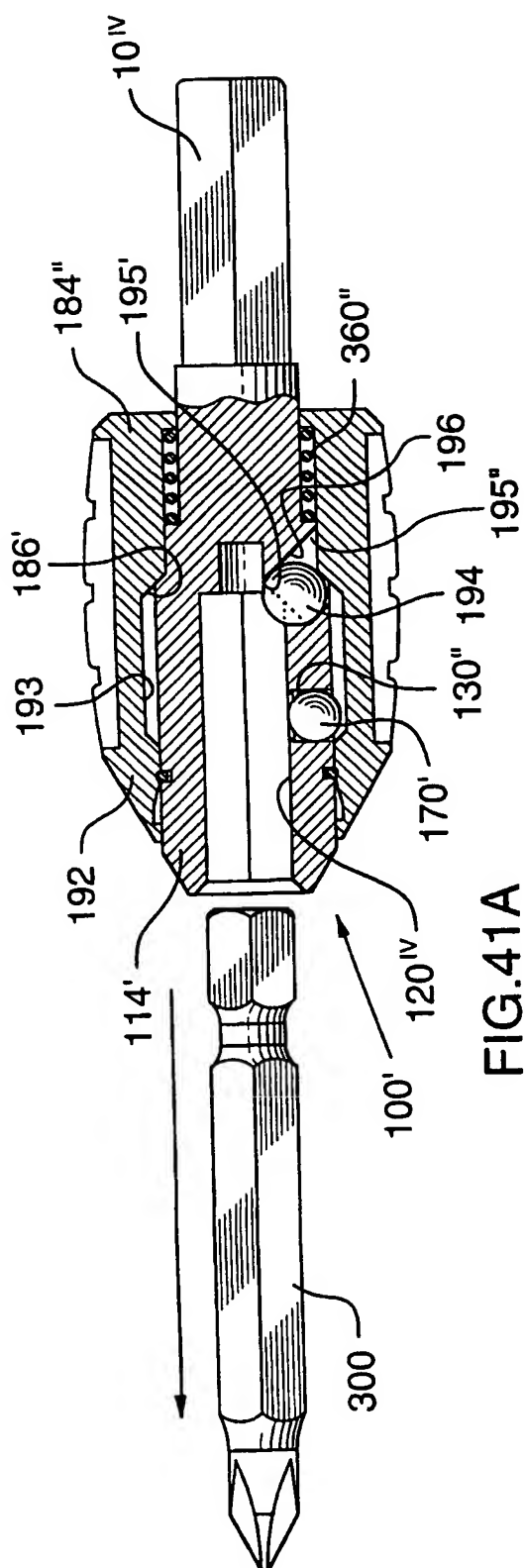


FIG. 40A

FIG. 40B

FIG. 40C



**FIG. 41A**

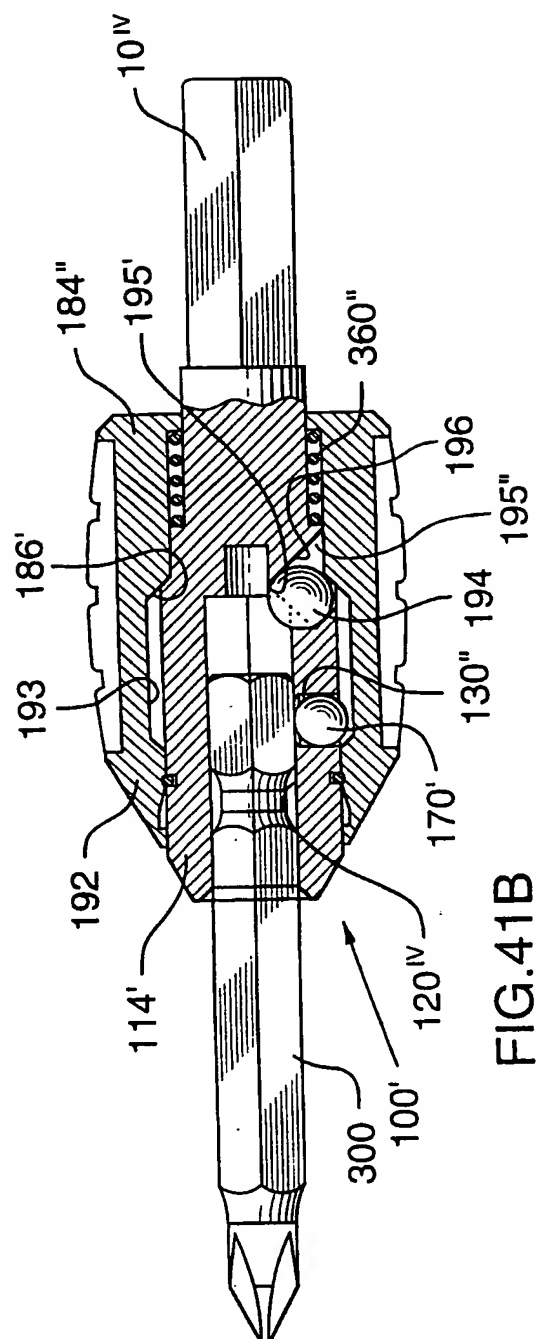


FIG. 41B

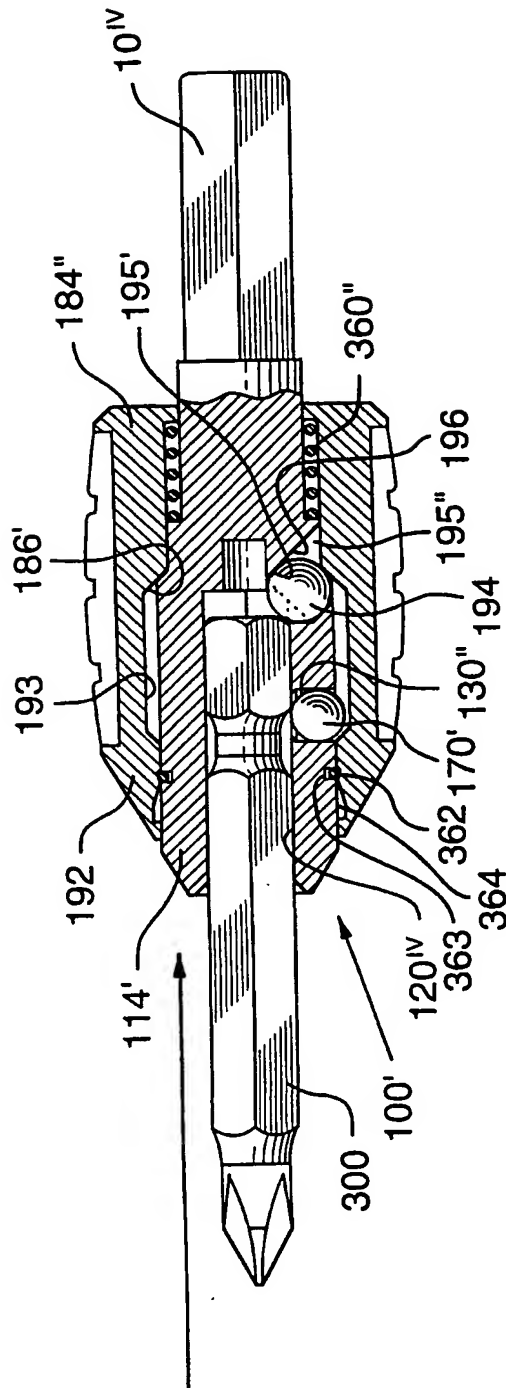


FIG. 41C

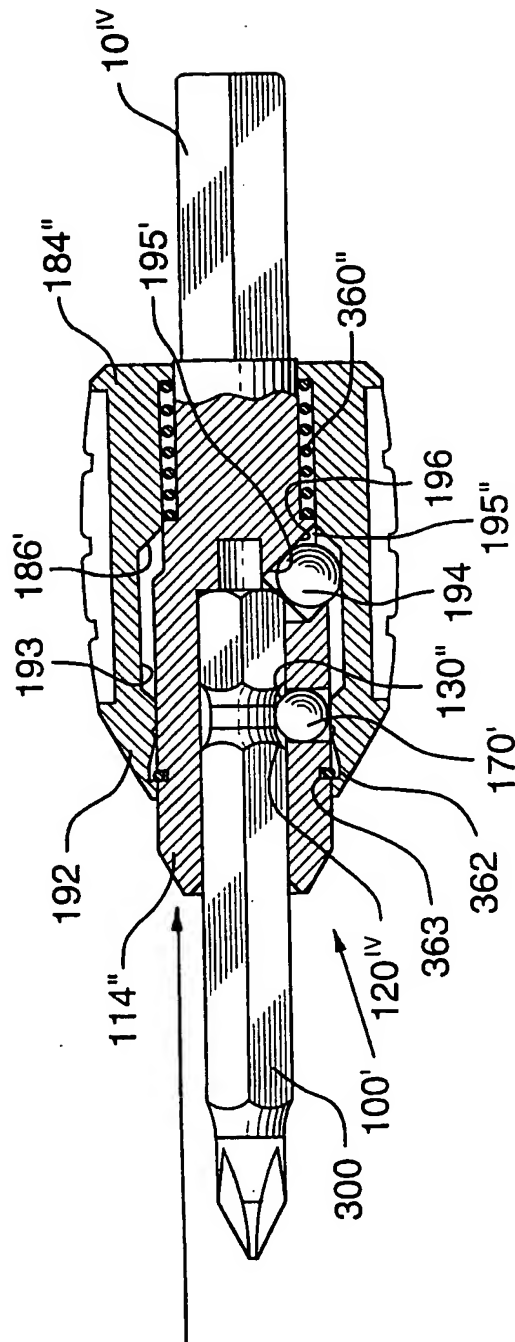
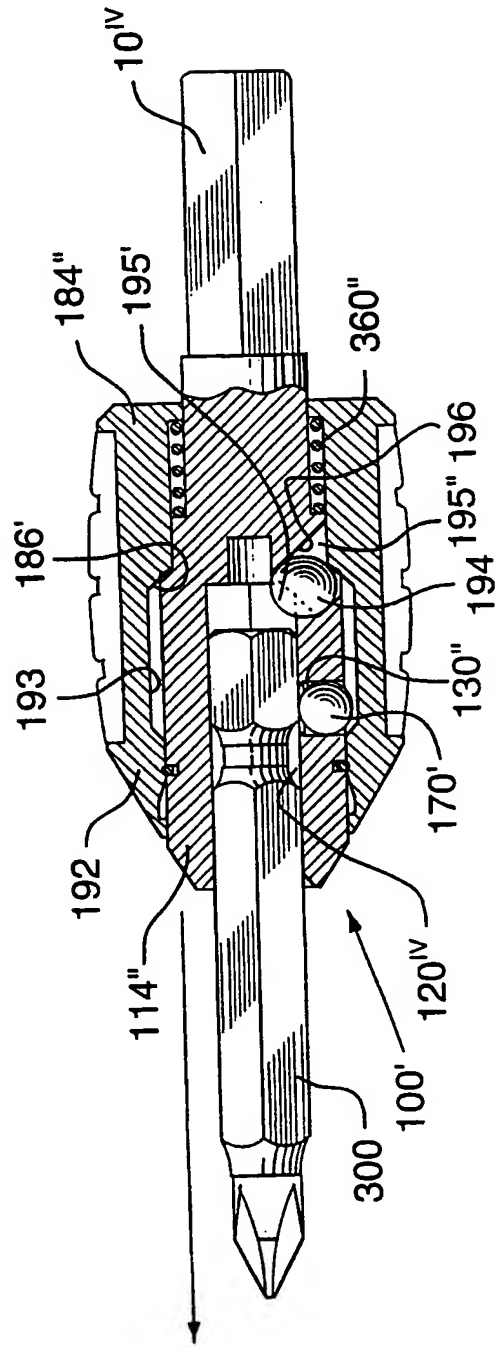
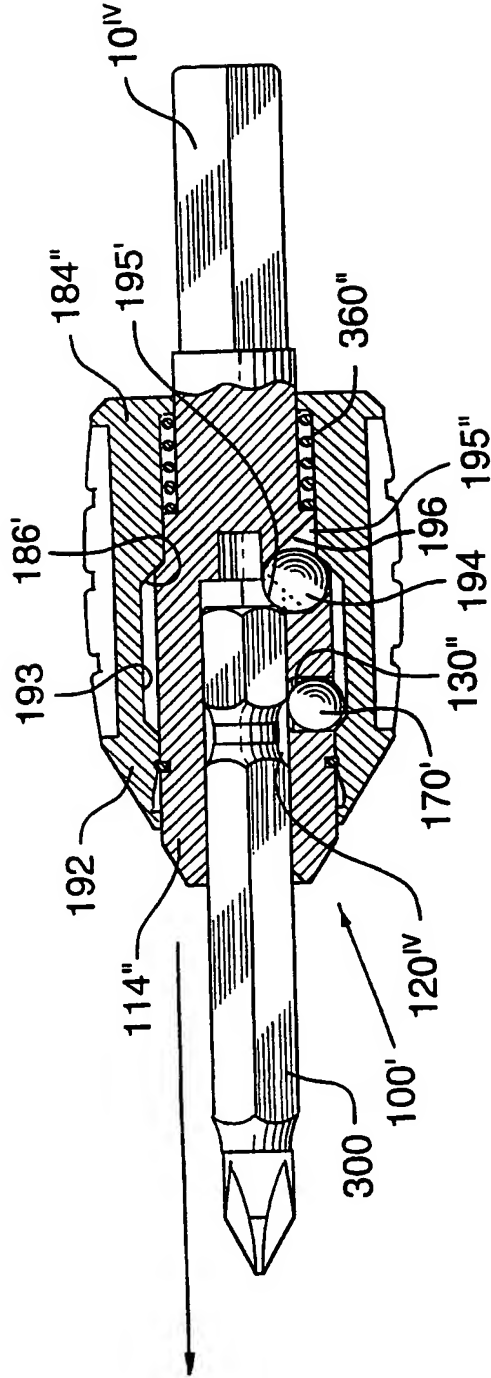


FIG. 41D



32/60

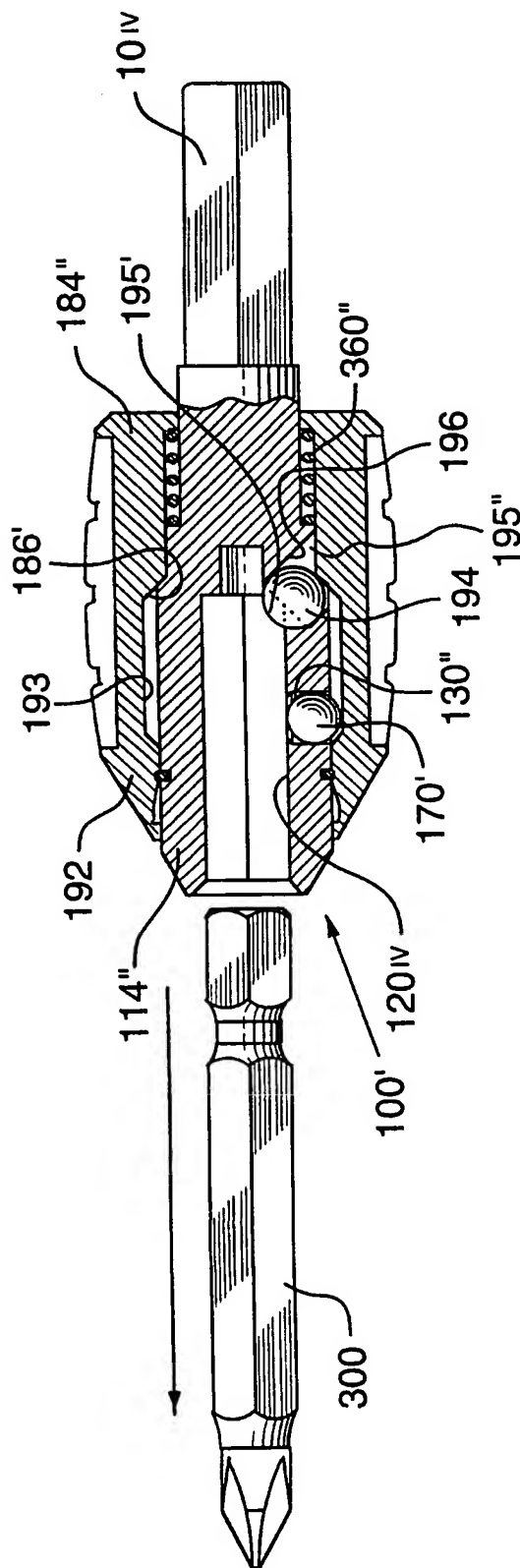


FIG. 41G

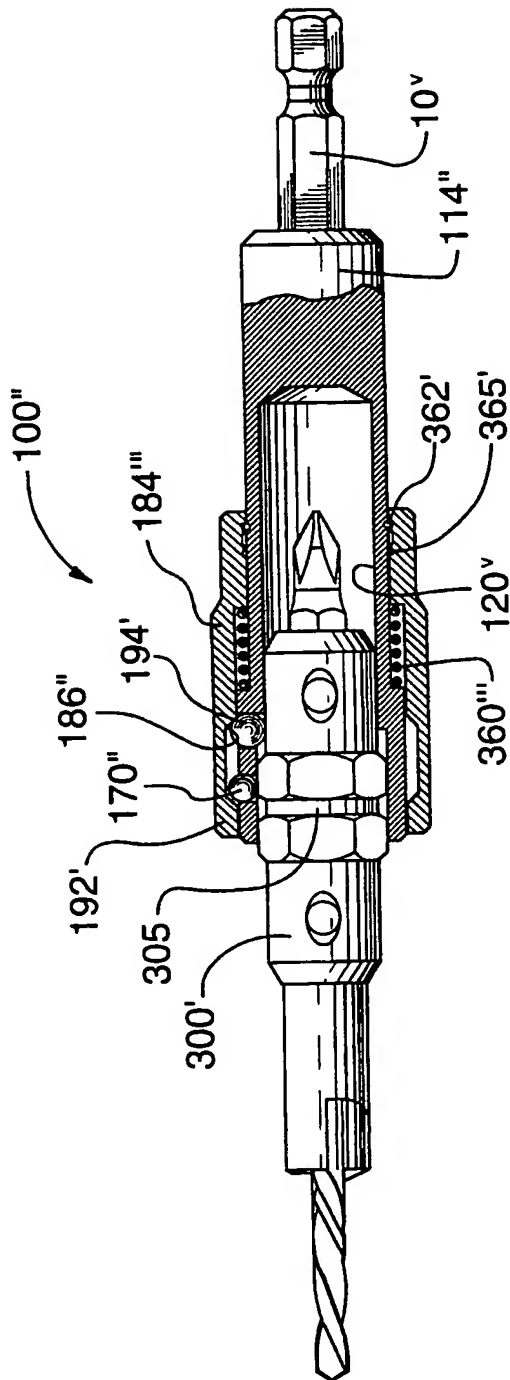


FIG. 42A

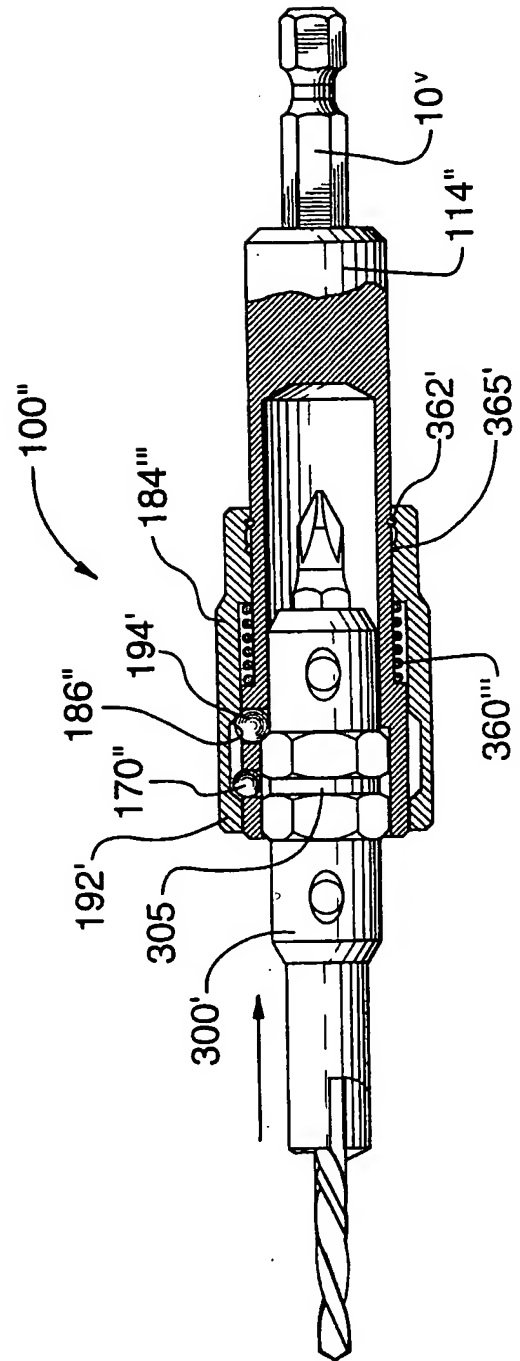


FIG. 42B

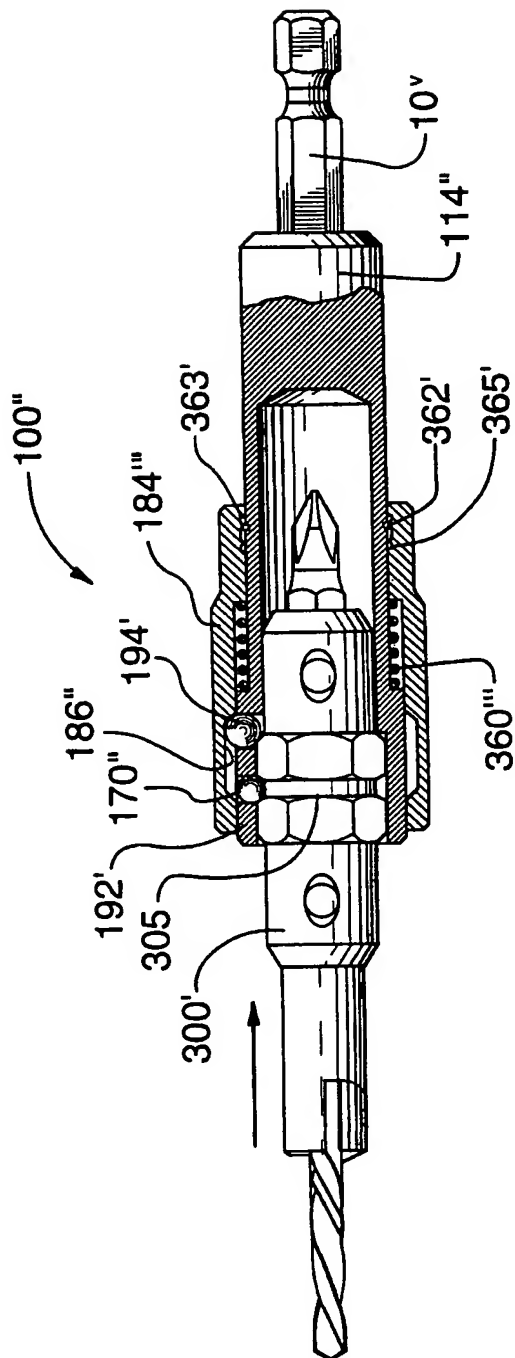


FIG. 42C

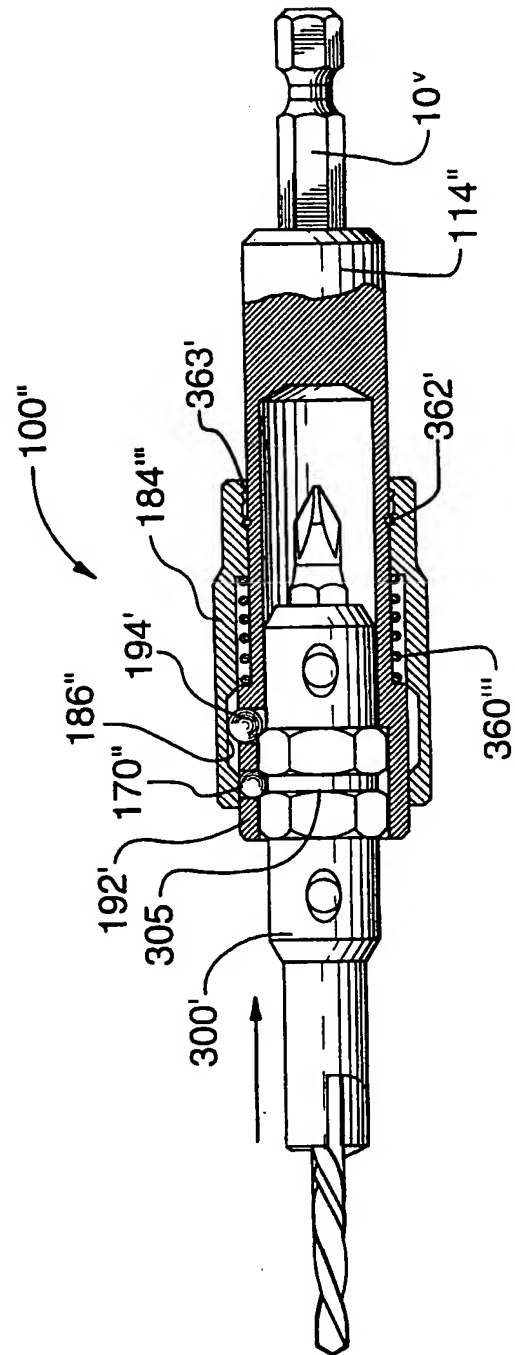


FIG. 42D

35/60

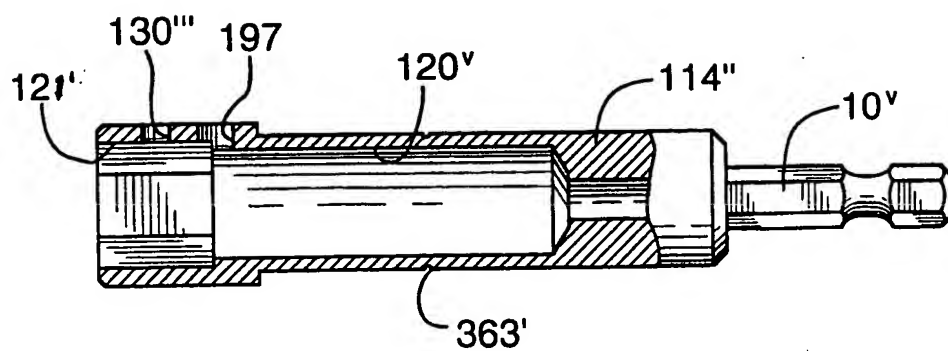


FIG. 43A

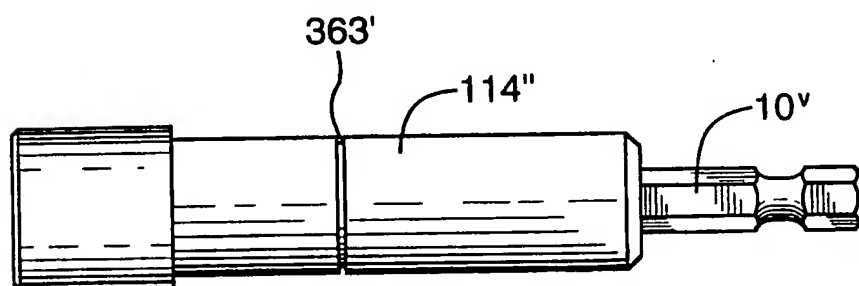


FIG. 43B

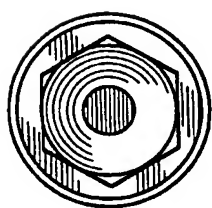


FIG. 43C

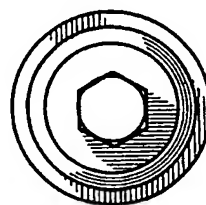


FIG. 43D



36/60

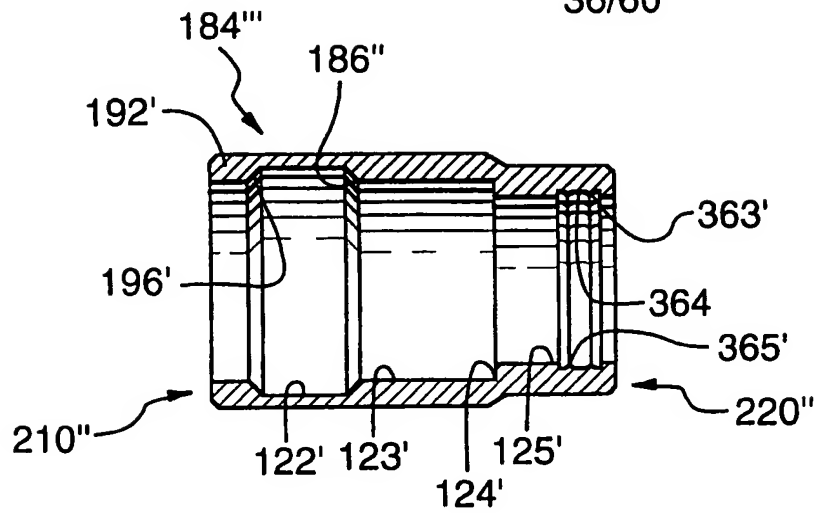


FIG. 44A

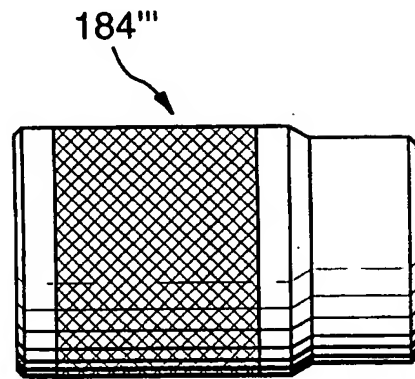


FIG. 44B

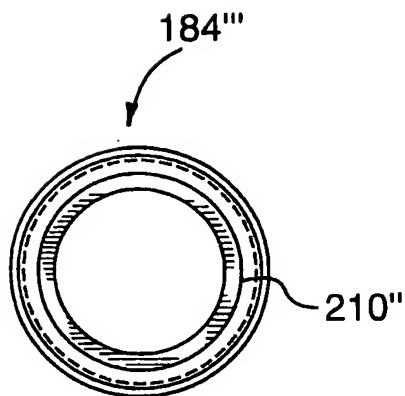


FIG. 44C

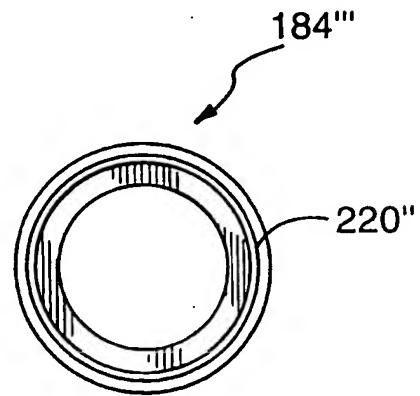


FIG. 44D

37/60

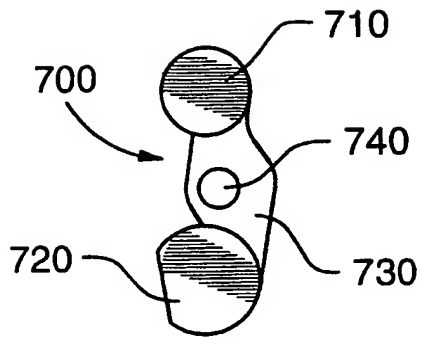


FIG. 47A

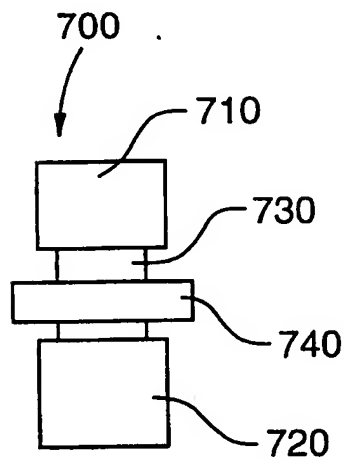


FIG. 47B

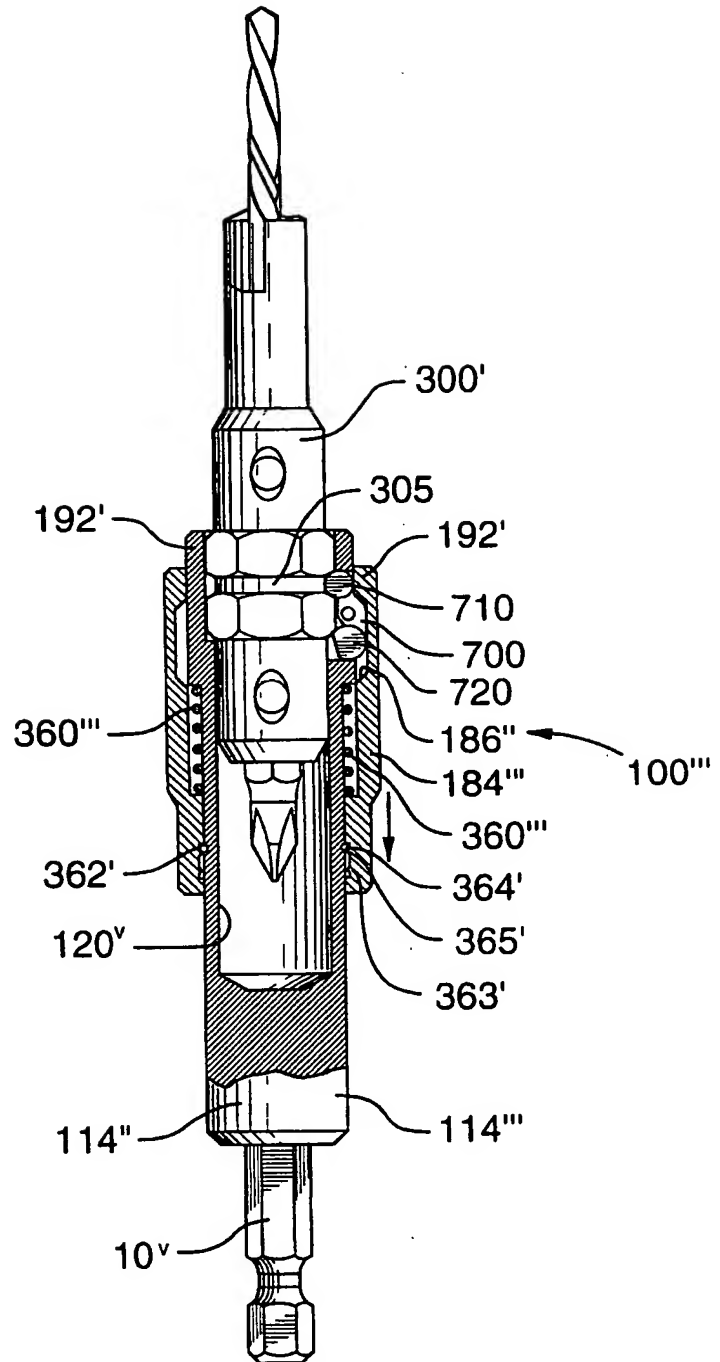


FIG. 45

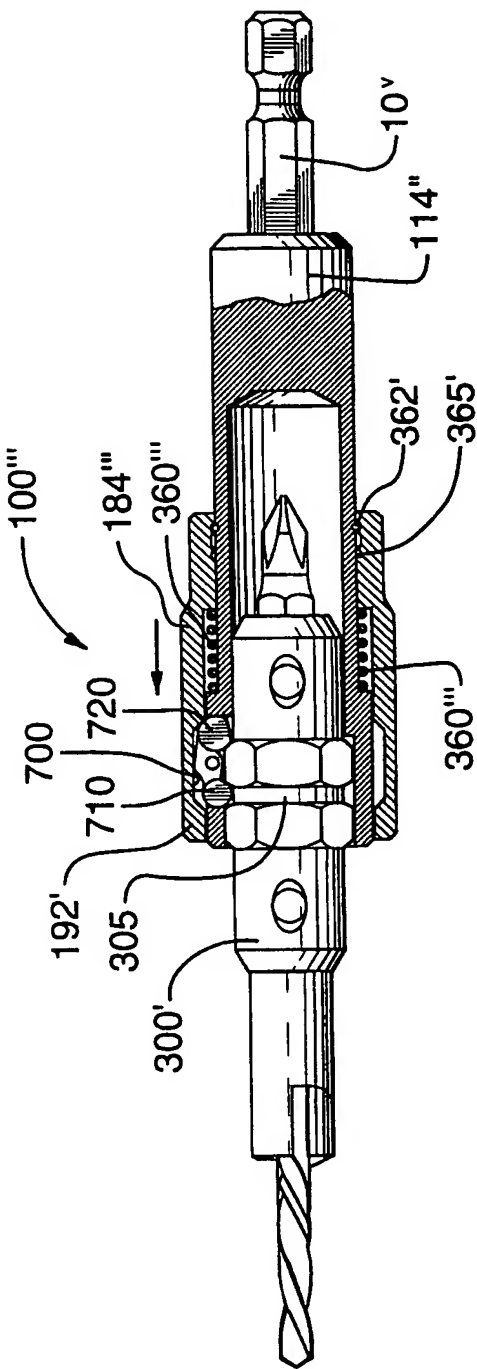


FIG. 46A

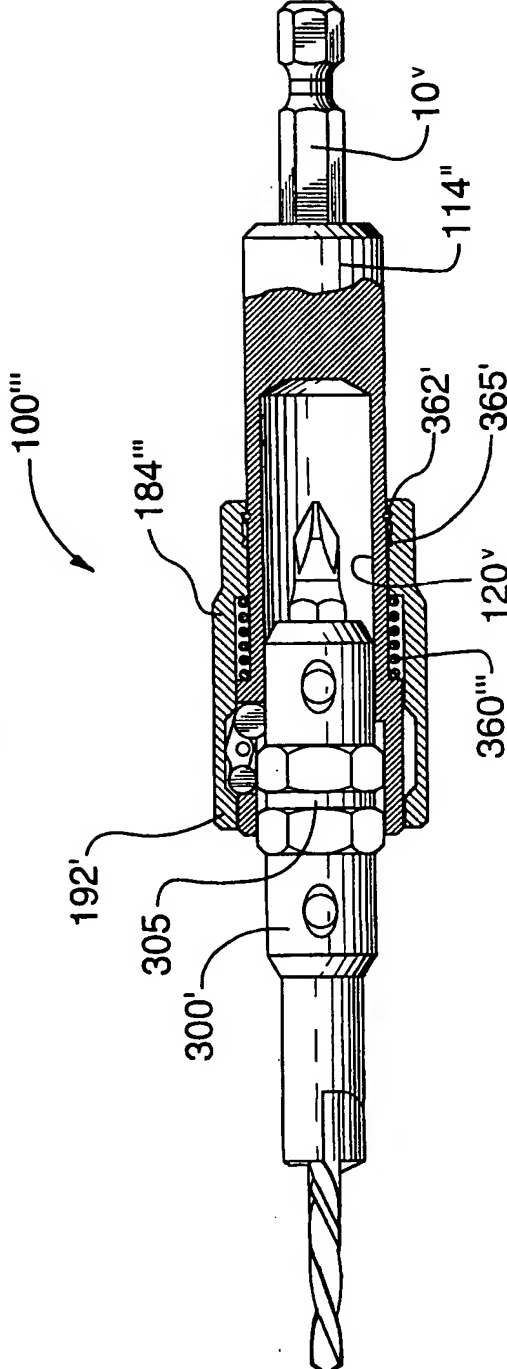


FIG. 46B

39/60

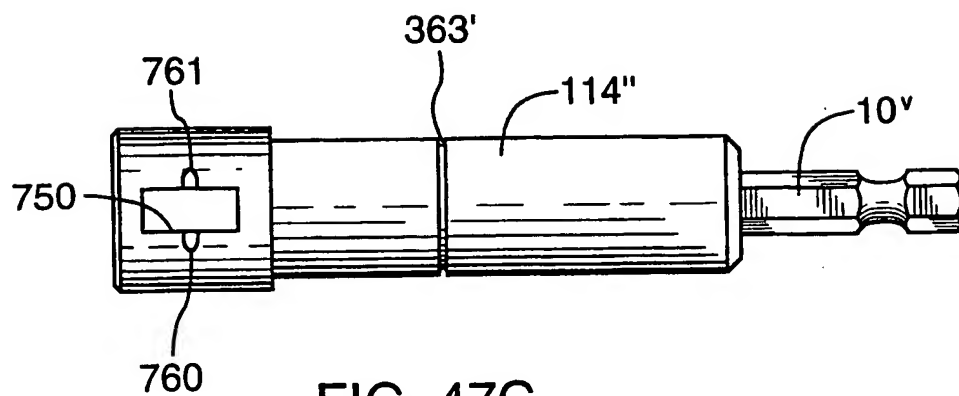


FIG. 47C

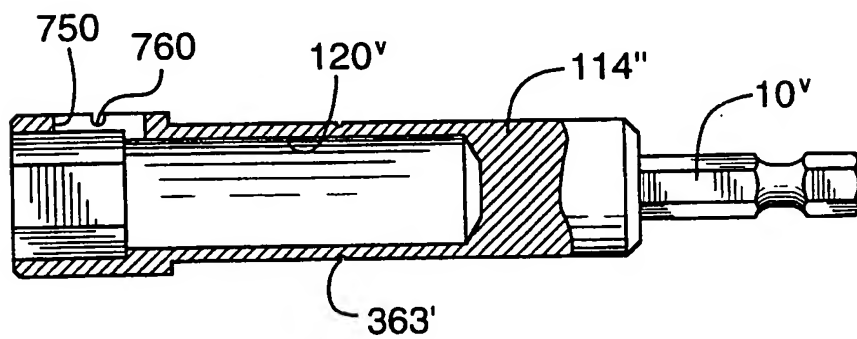


FIG. 47D

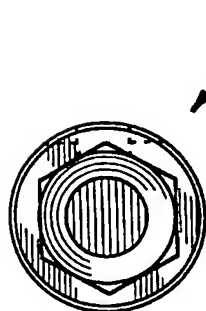


FIG. 47F

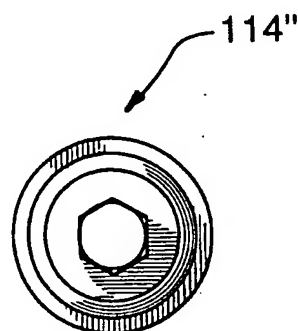
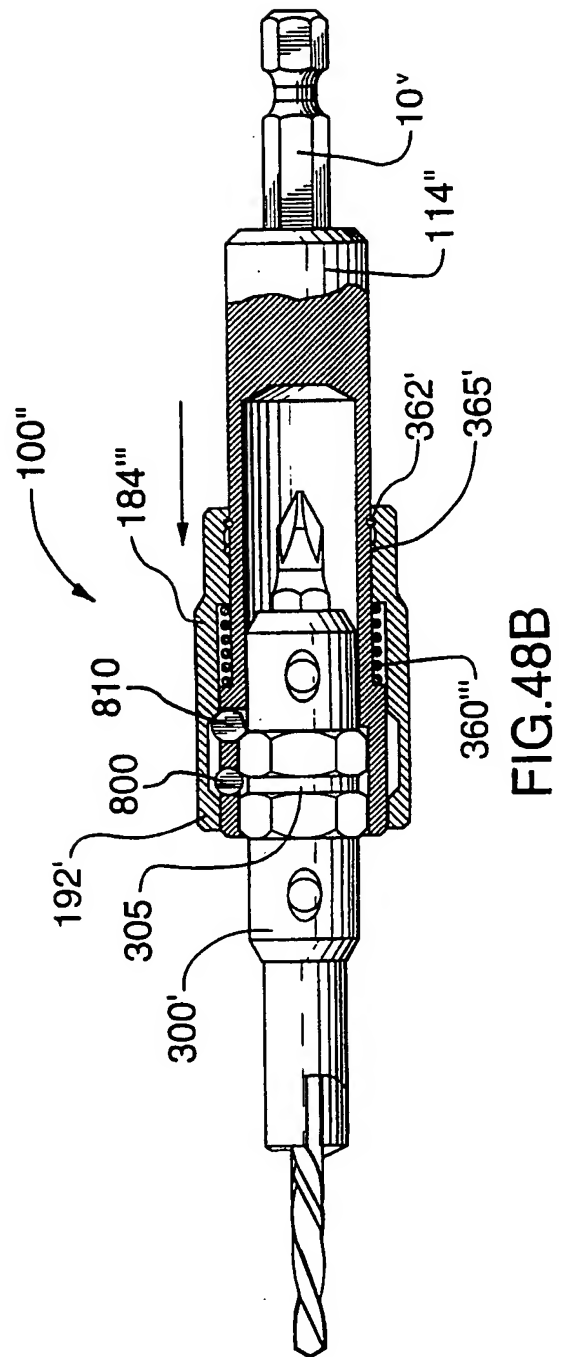
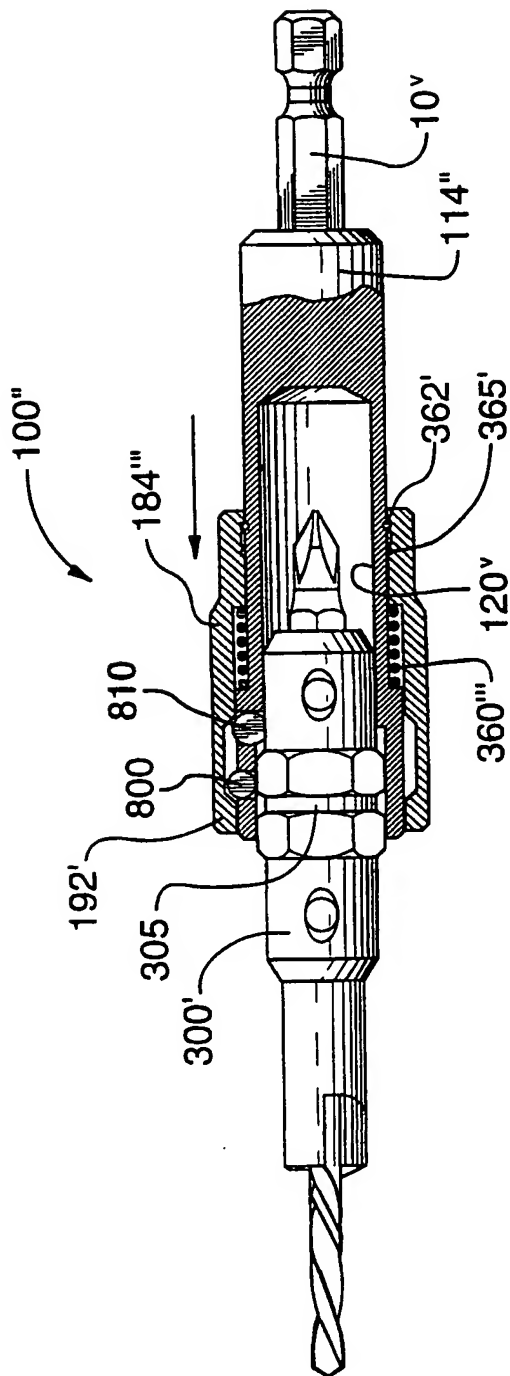


FIG. 47E





42/60

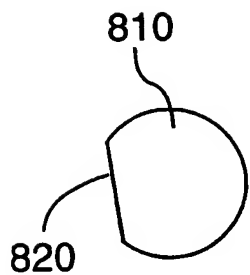


FIG. 49A

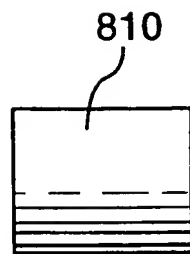


FIG. 49B

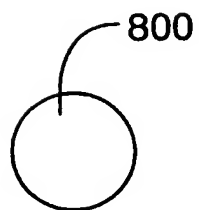


FIG. 50A

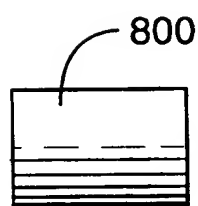


FIG. 50 B

43/60

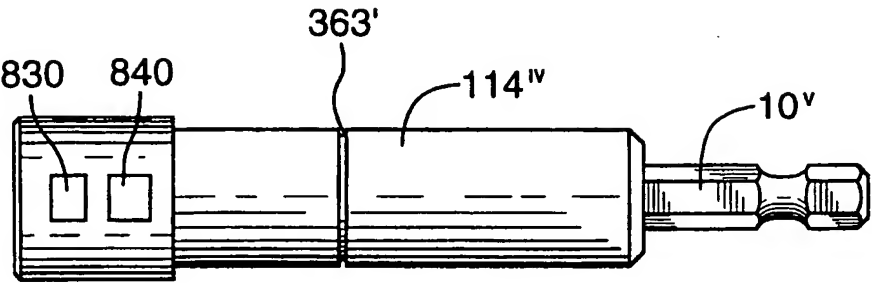


FIG. 51A

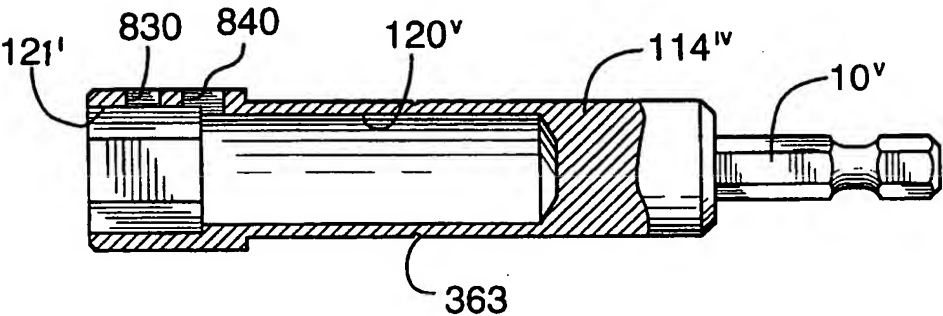


FIG. 51B

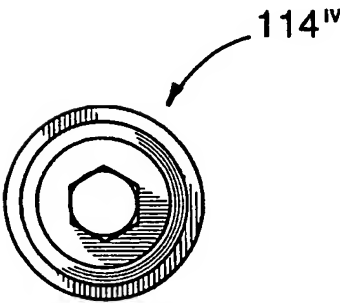


FIG. 51C

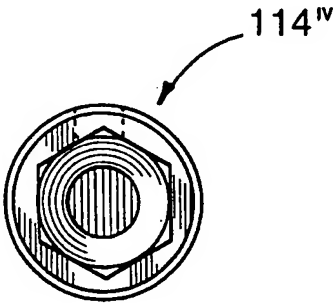
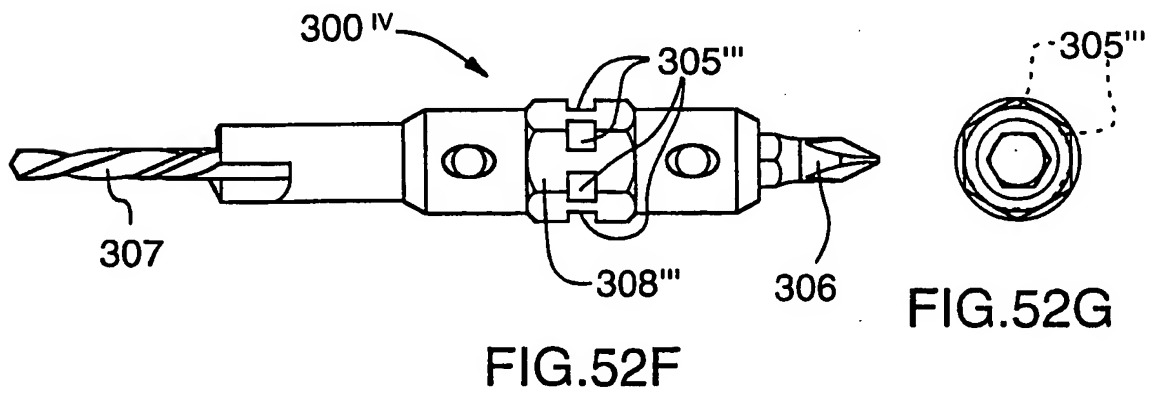
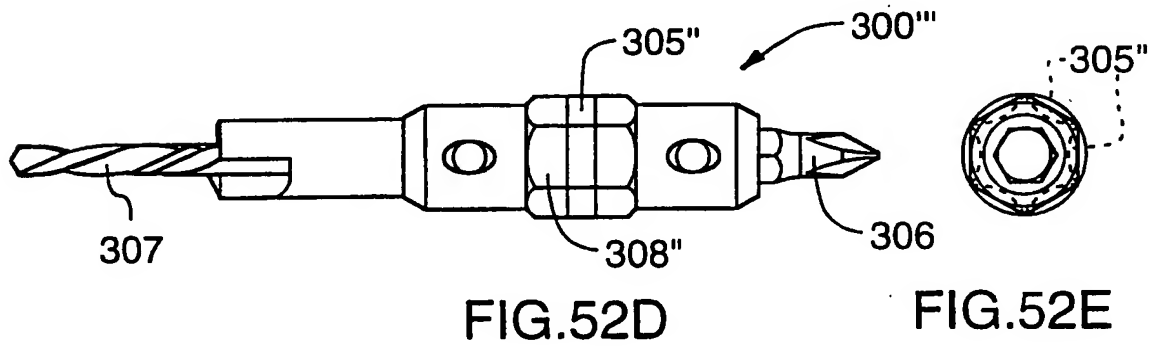
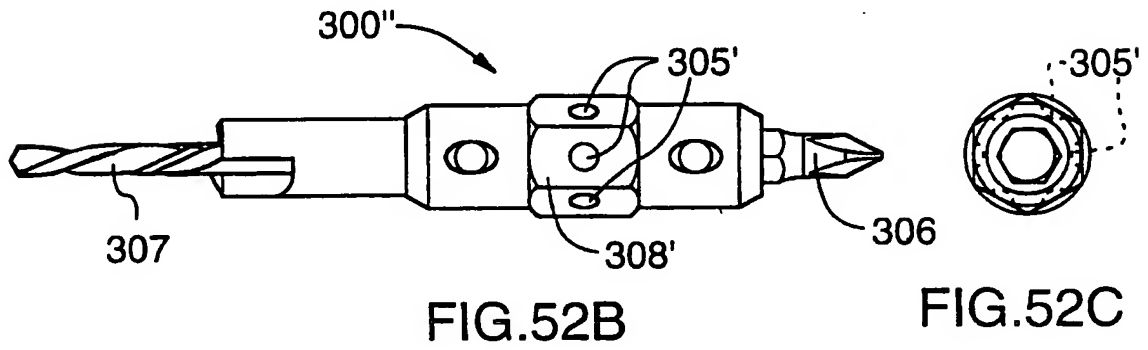
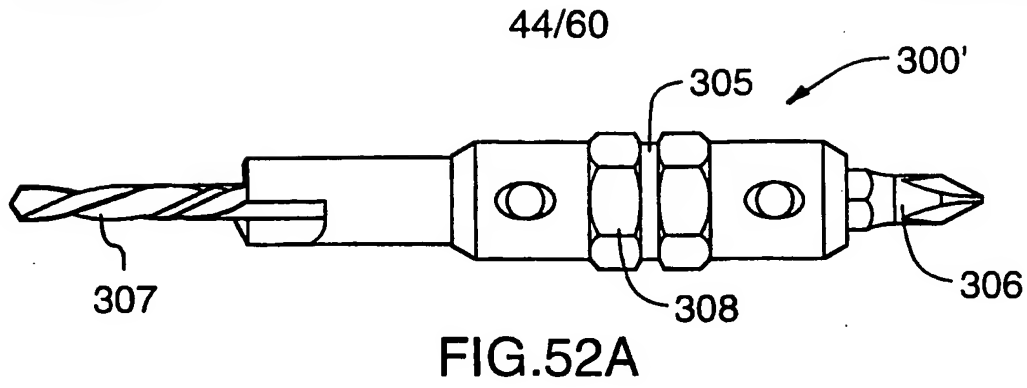
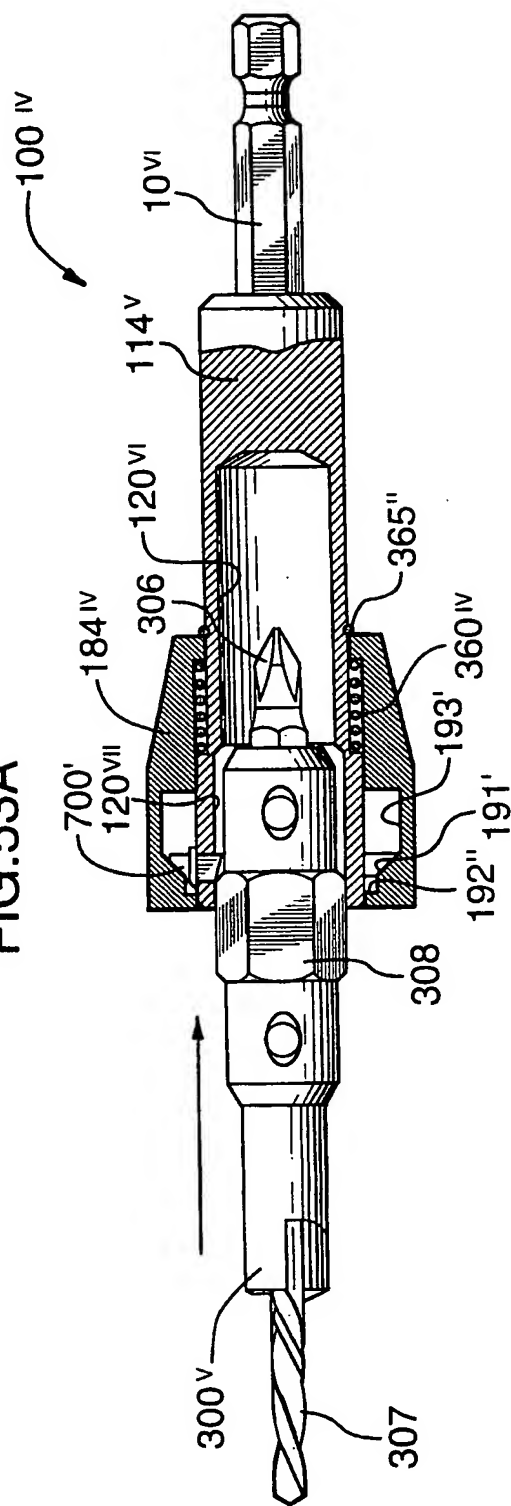
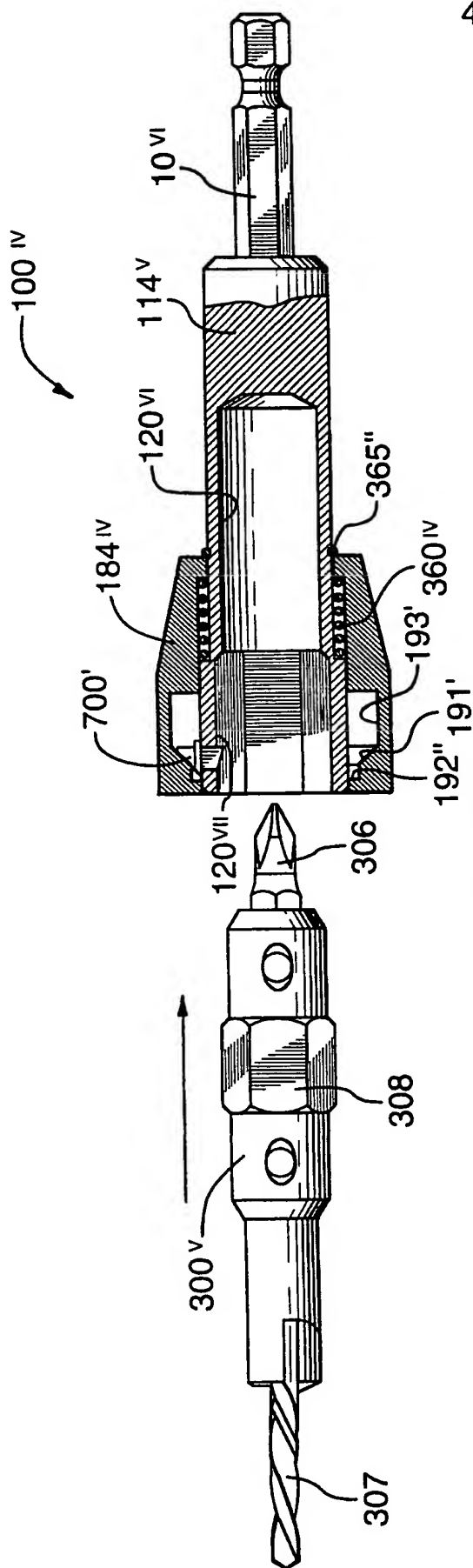


FIG. 51D







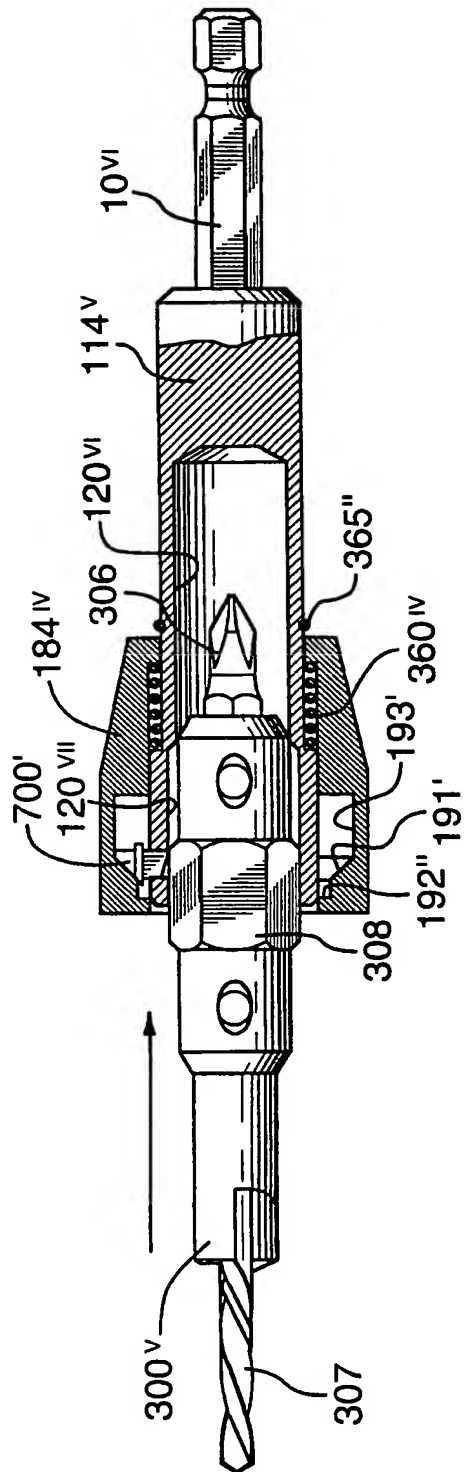


FIG. 53C

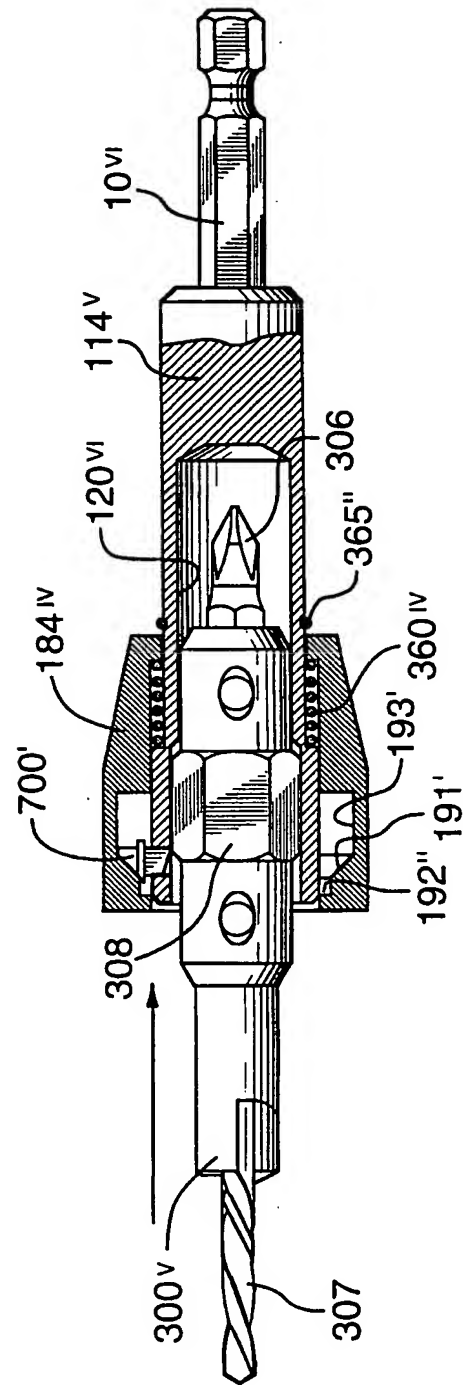


FIG. 53D

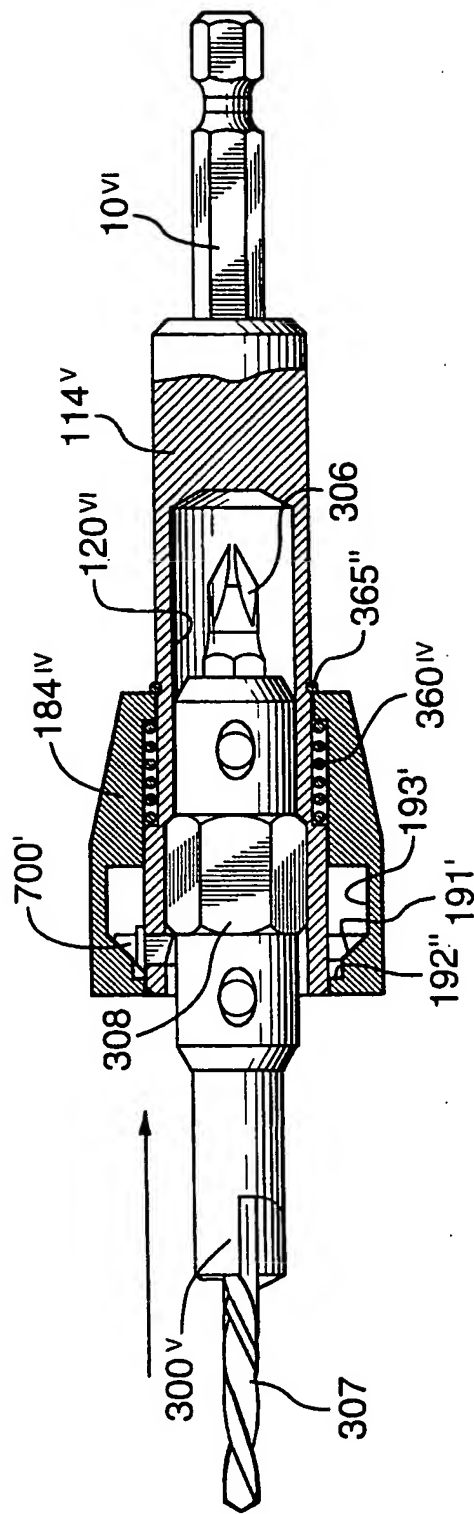
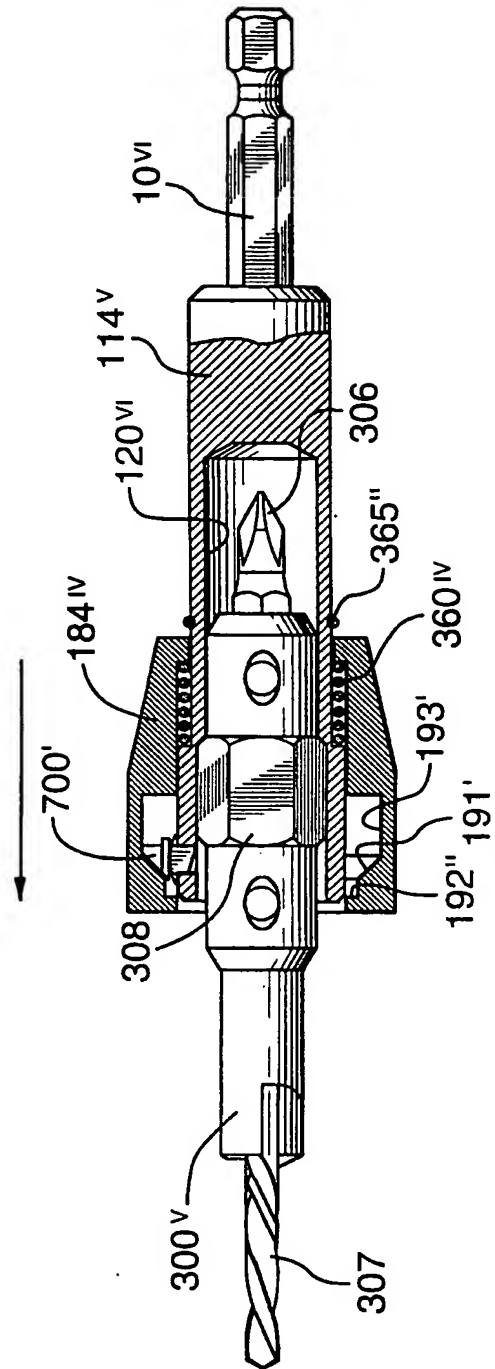
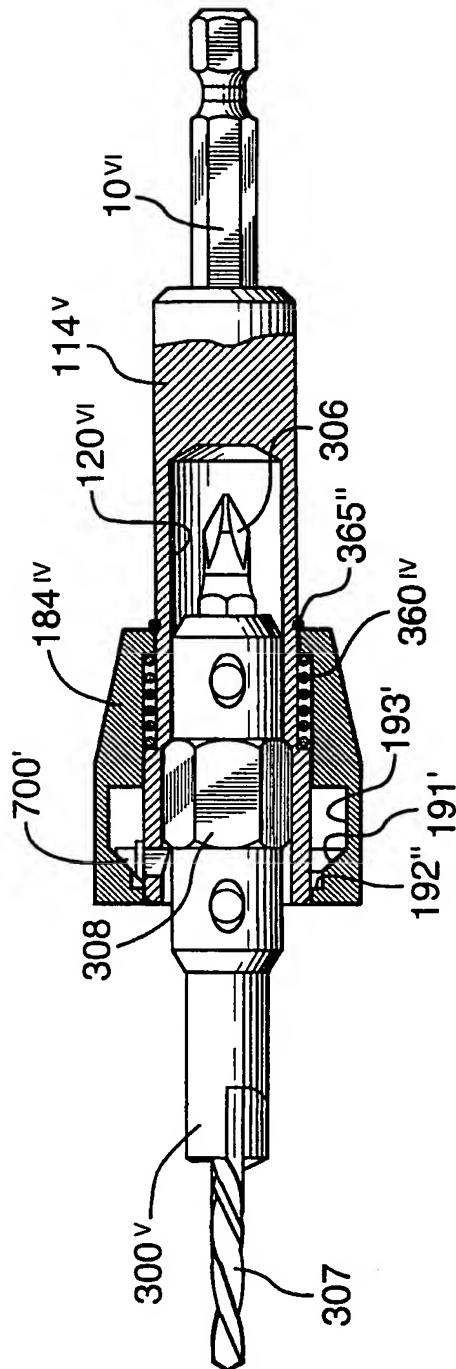


FIG. 53E



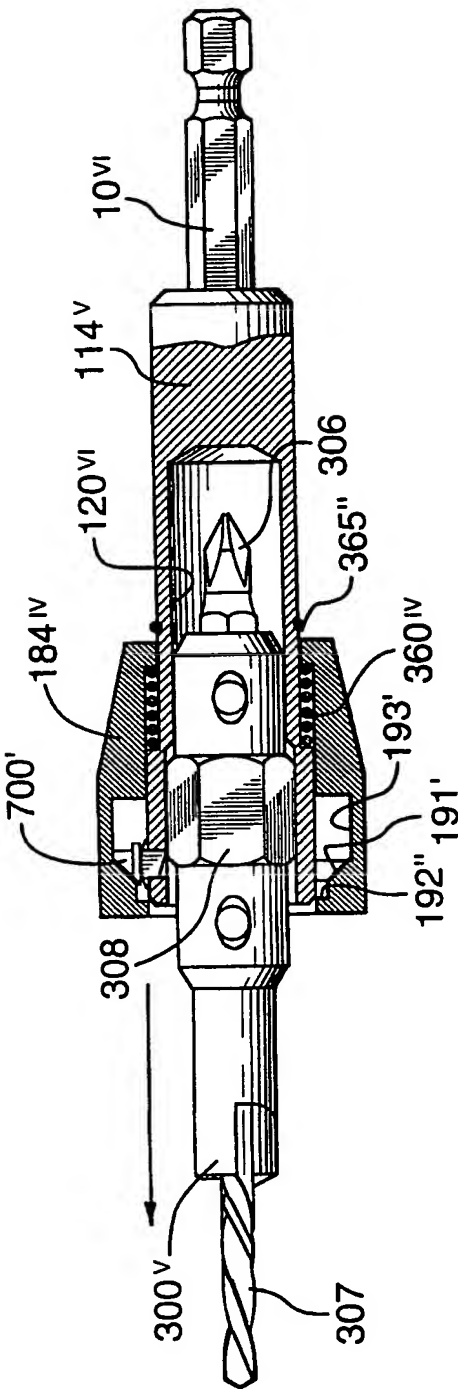


FIG. 54C

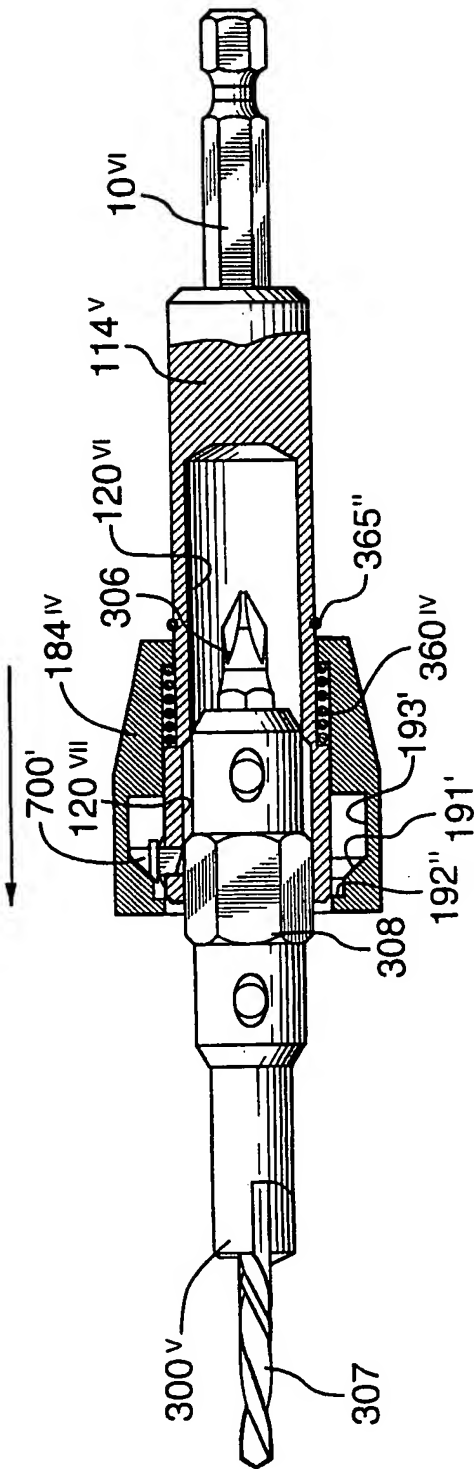
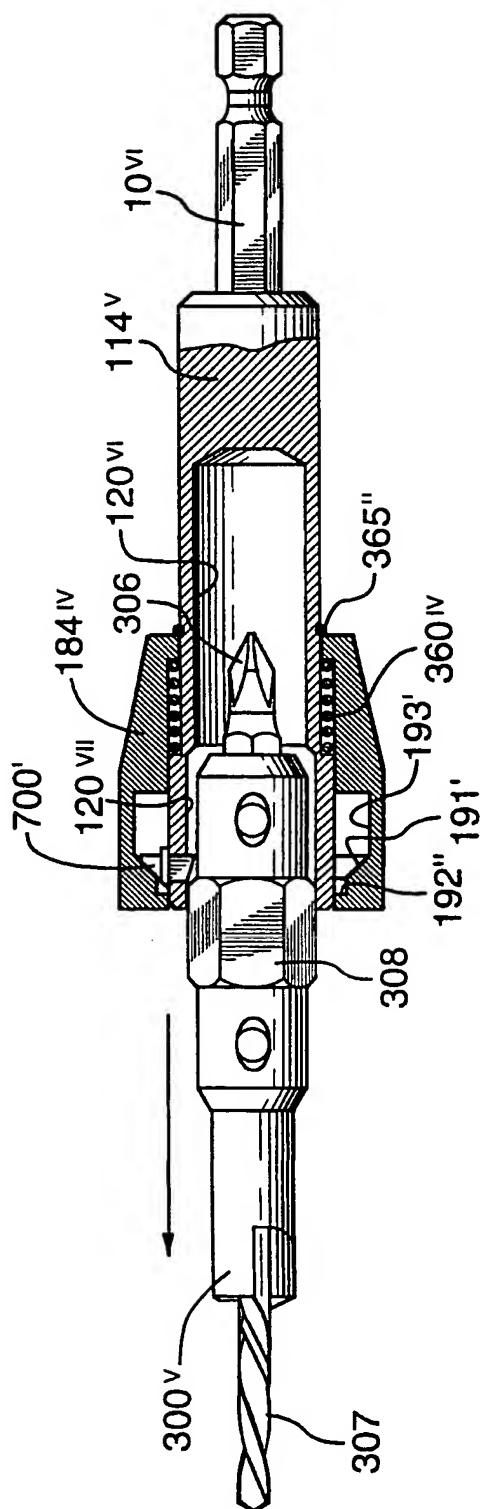


FIG. 54D



51/60

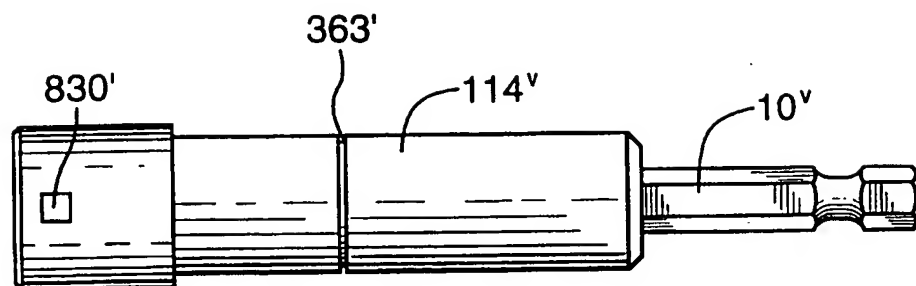


FIG. 55A

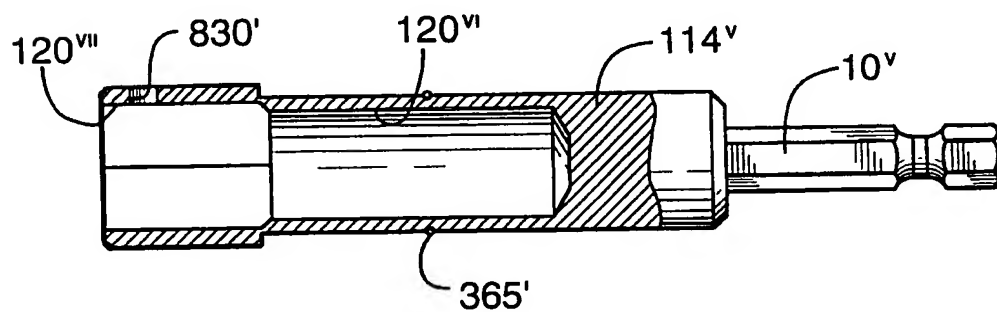


FIG. 55B

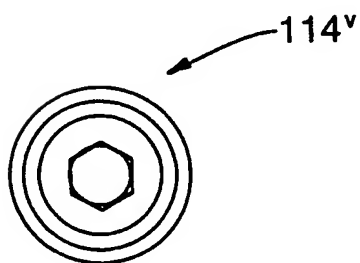


FIG. 55C

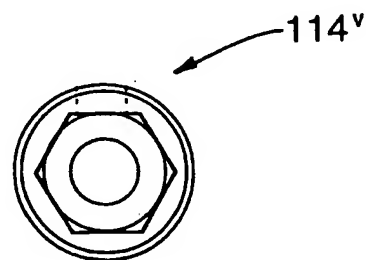


FIG. 55D



52/60

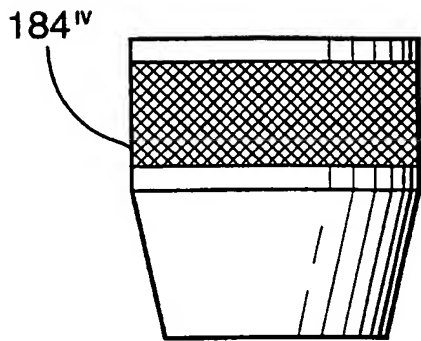


FIG. 56A

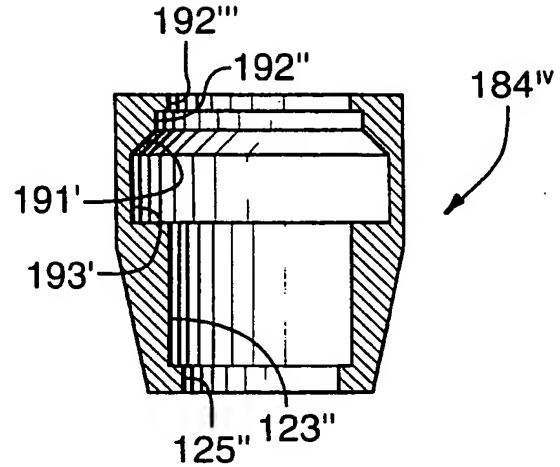


FIG. 56B

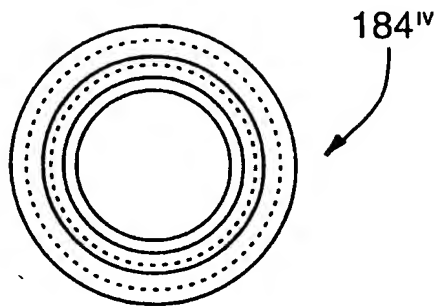


FIG. 56C

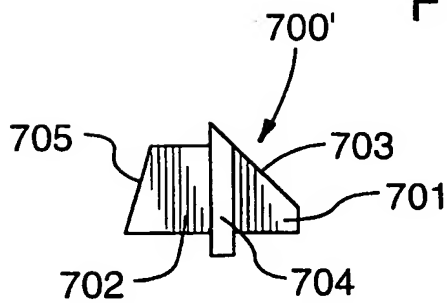


FIG. 57A

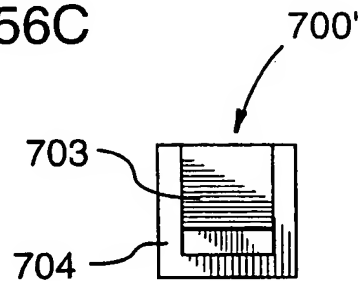


FIG. 57B

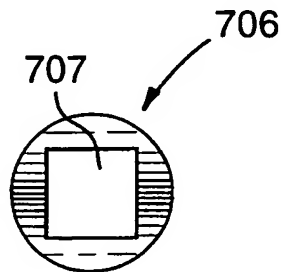


FIG. 58A

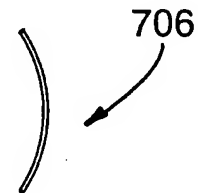


FIG. 58B

53/60

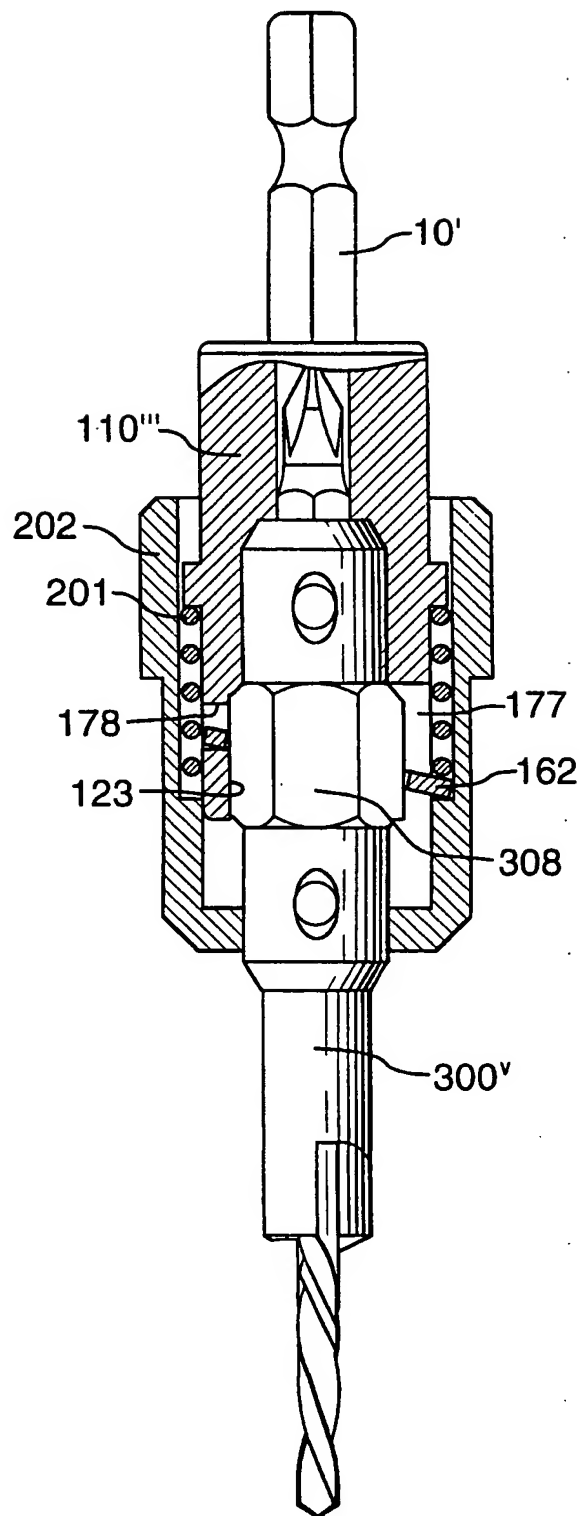
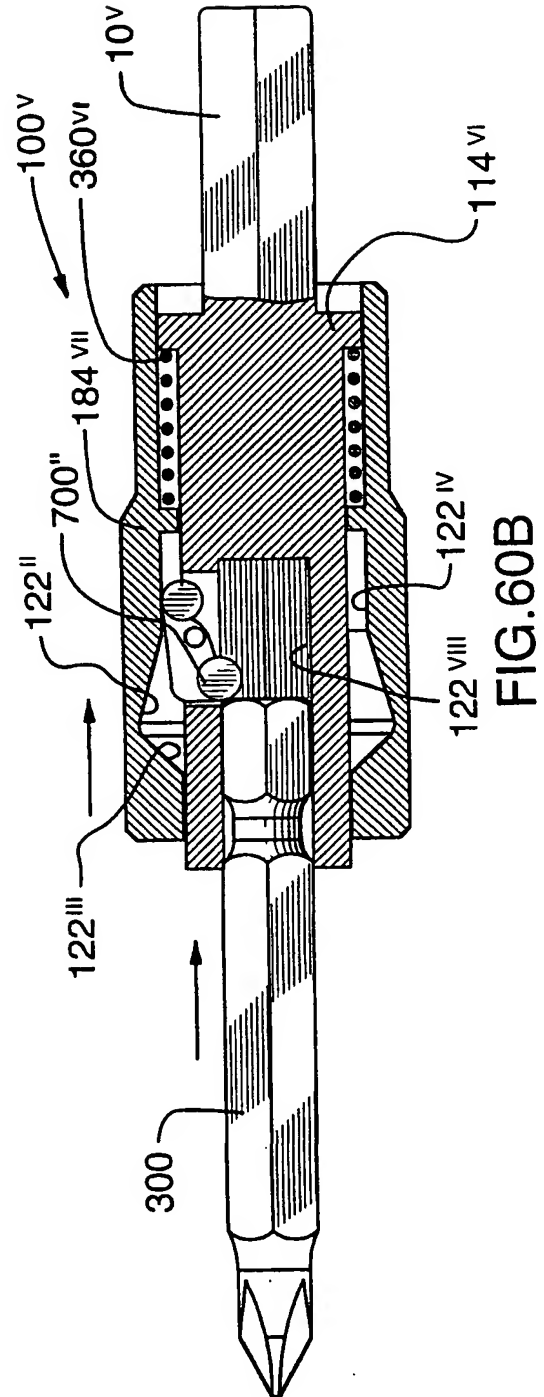
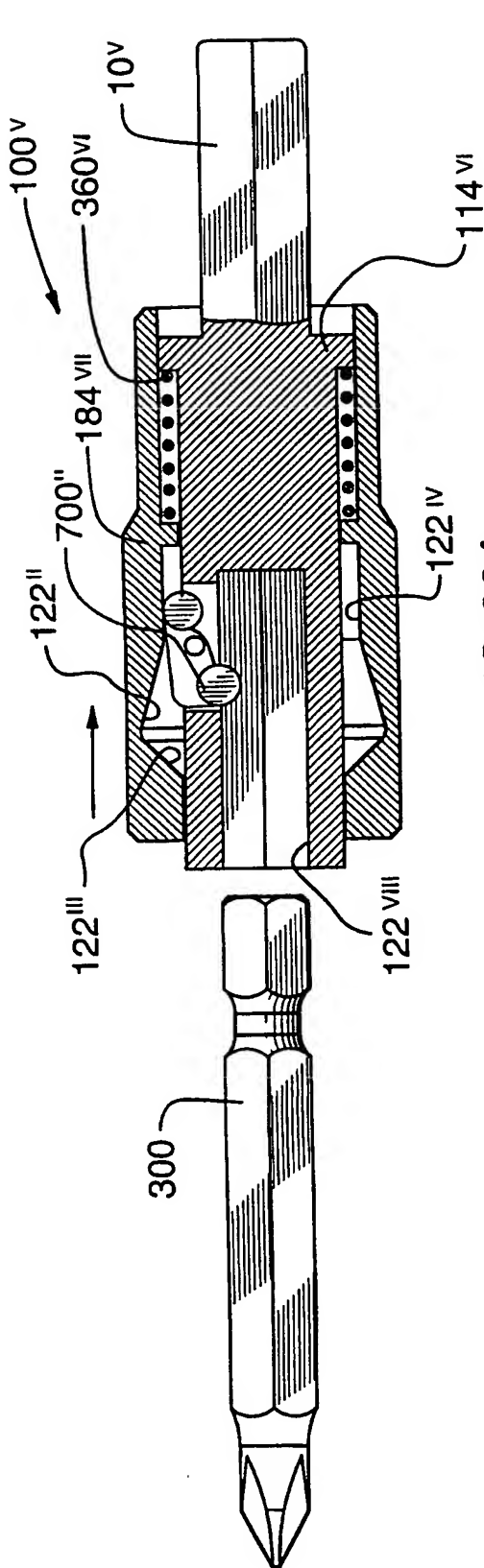


FIG.59



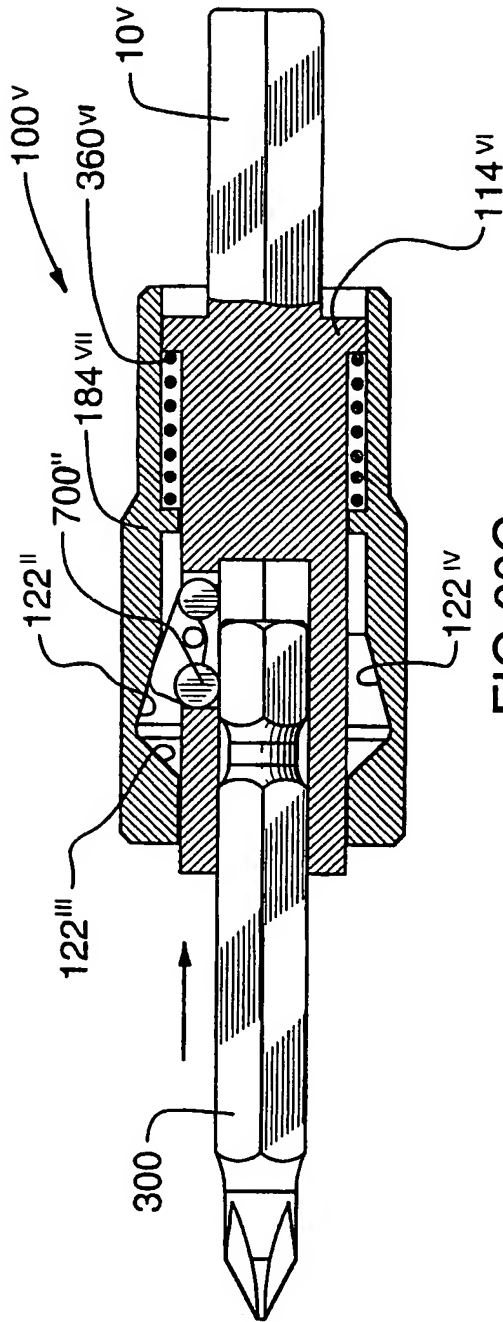


FIG. 60C

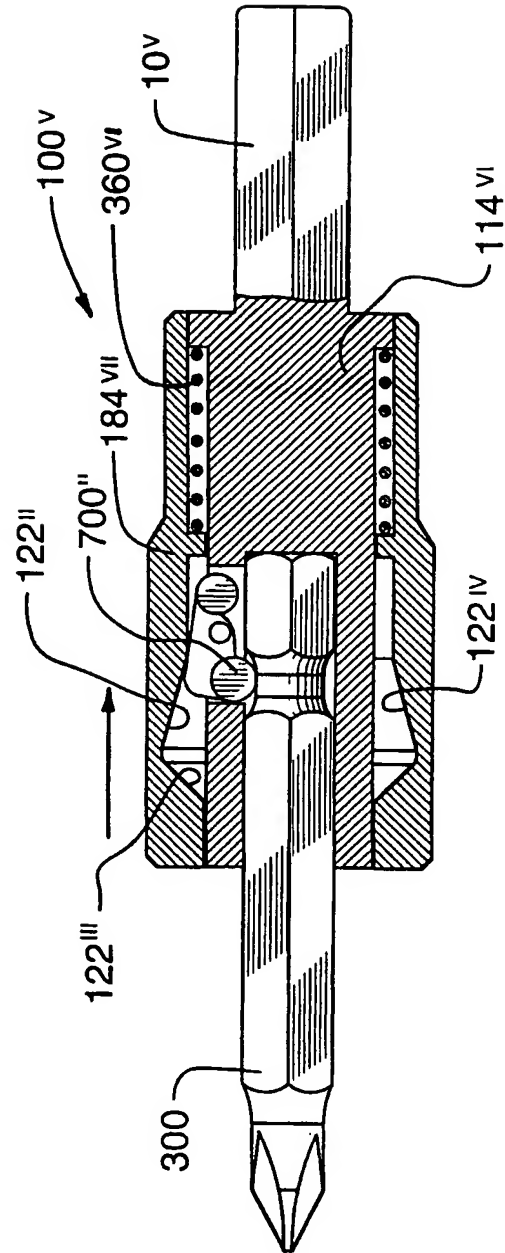


FIG. 60D

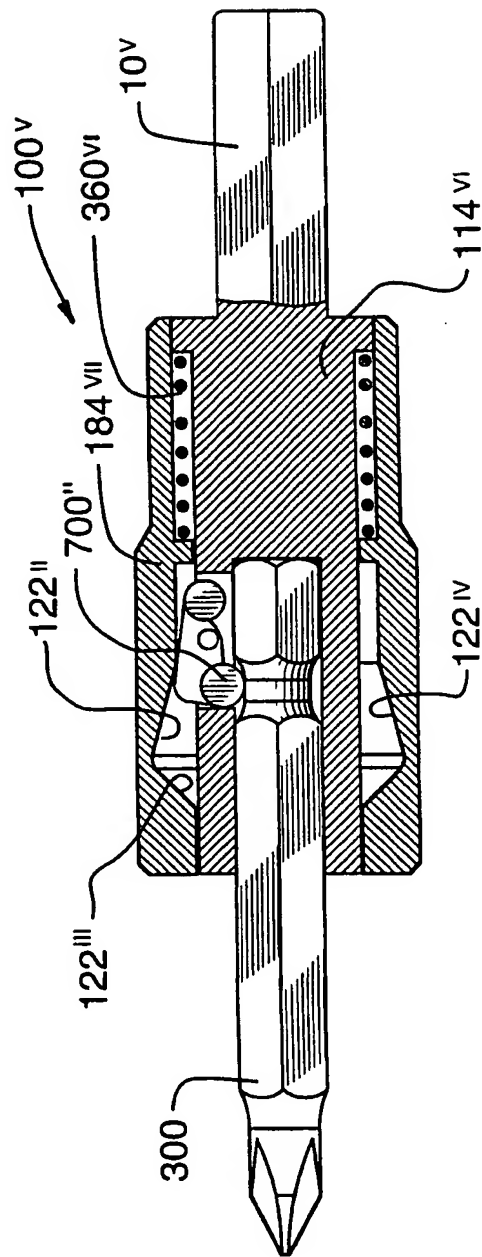


FIG. 60E

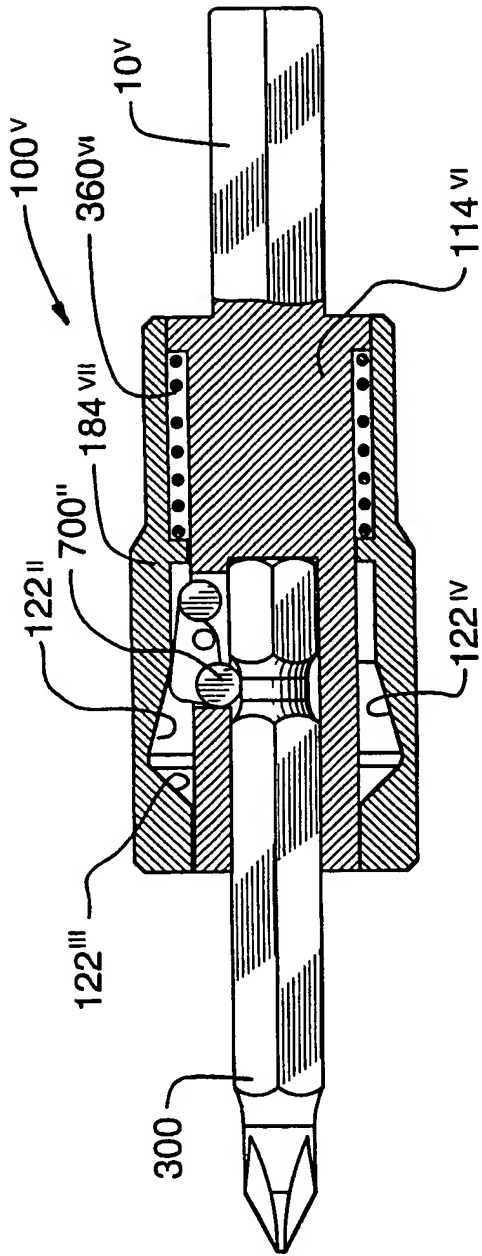


FIG. 61A

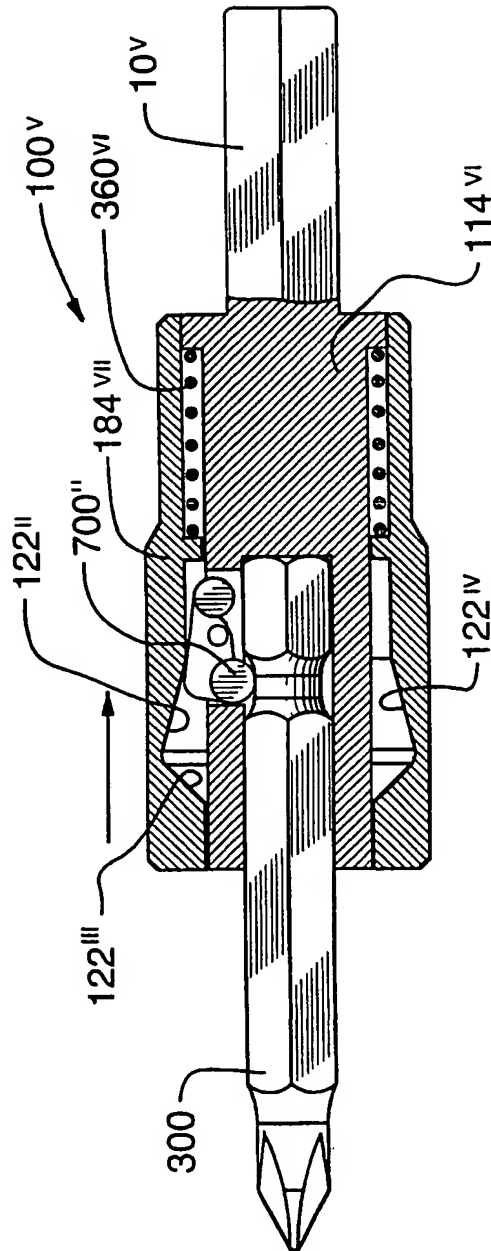
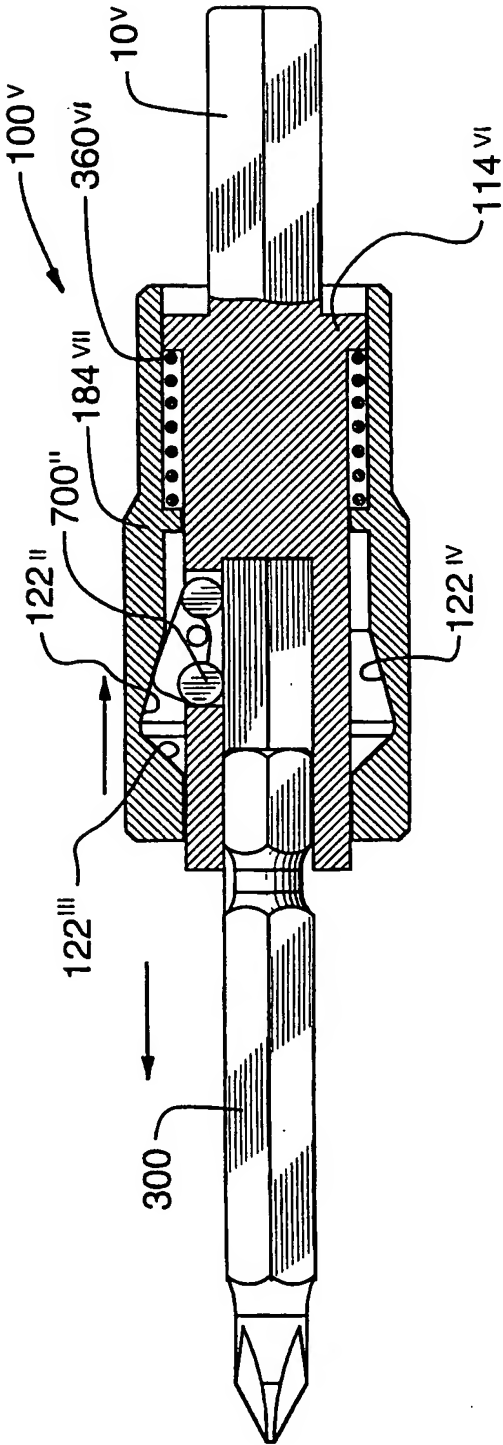
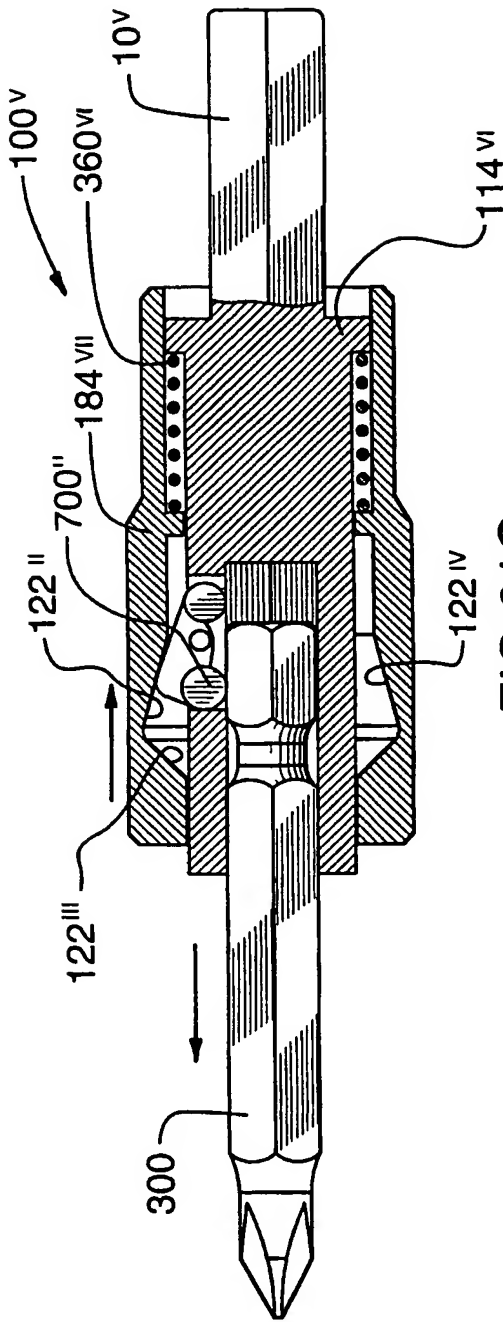
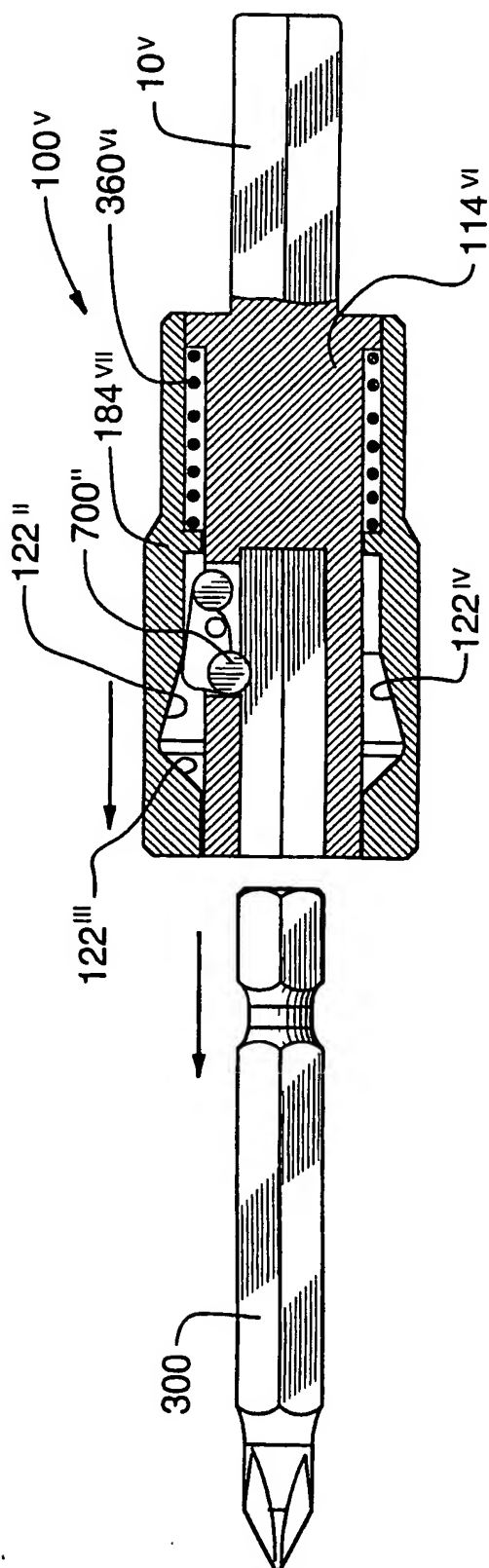


FIG. 61B



59/60





60/60

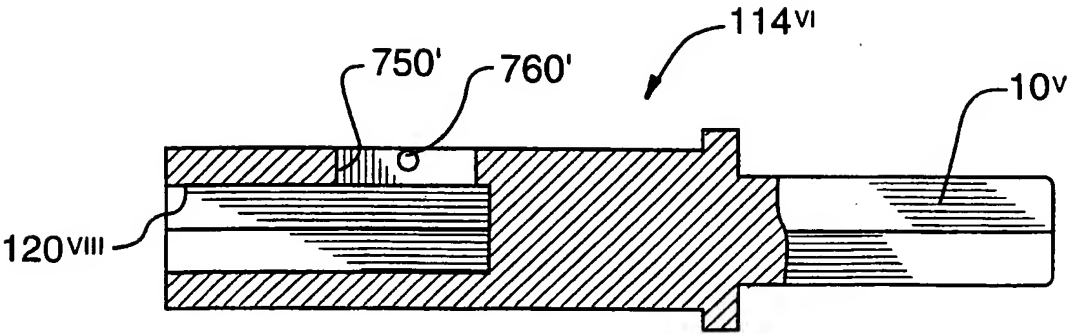


FIG. 62A

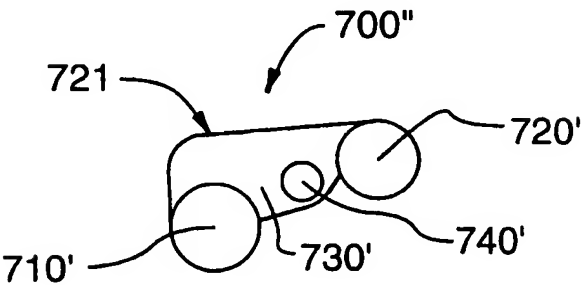


FIG. 62B

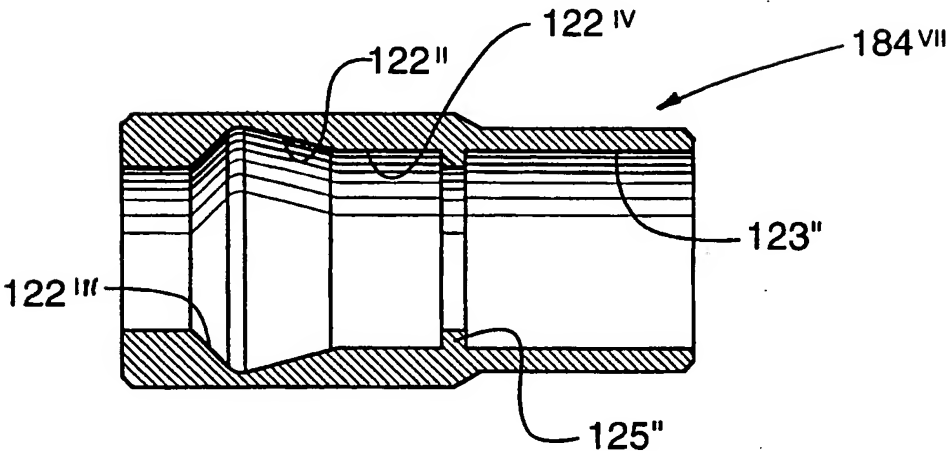


FIG. 62C